Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

FEBRUARY, 1958 TECHNOLOGY DEPT.

TABLE OF CONTENTS, PAGE 3

Ohio Rolls

shaping metal for all Industry

Ohio Iron and Steel Rolls

Carbon Steel Rolls
Ohioloy Rolls
Ohioloy "K" Rolls
Flintuff Rolls
Double-Pour Rolls
Chilled Iron Rolls
Dense Iron Rolls
Nickel Grain Rolls
Special Iron Rolls
Nioloy Rolls
Forged Steel Rolls

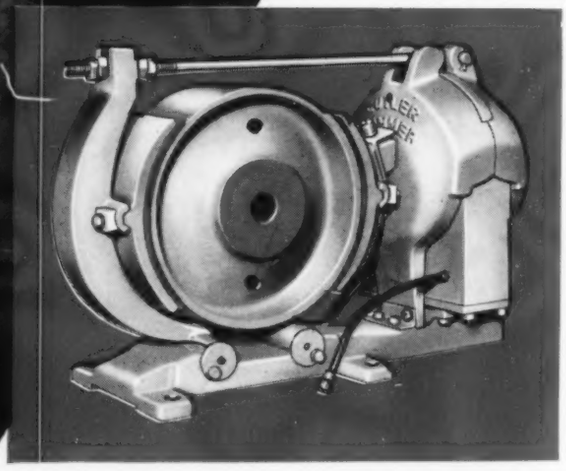
THE OHIO STEEL FOUNDRY CO.

LIMA, OHIO

Plants at Lima and Springfield, Ohio

LIMA... Virtually at the center of the steel industry

The Cutler-Hammer 505 Mill Brake can be adjusted perfectly in total darkness



Mill brakes are often installed in hard-to-reach places where there is very little light. Yet, as every mill man knows, they must be kept adjusted for lining wear. This is no problem when the brake is a Cutler-Hammer 505! It can be adjusted perfectly in total darkness.

A man doesn't need a flashlight . . . or a third hand to hold one . . . when adjusting a Cutler-Hammer 505 Brake. With one hand he turns the adjusting nut and with the other hand he simply *feels* the indicating pins. When these pins are flush with their housing, the brake shoes are in *perfect* adjustment. There are no scales to read, nothing to measure, no tedious testing or climbing up and down for readjustments.

Compare the Cutler-Hammer 505 Mill Brake with any others. The biggest users of magnetic brakes say the 505 has no equal . . . in design, in construction, and in performance. Compare and prove it. CUTLER-HAMMER Inc., 1269 St. Paul Ave., Milwaukee 1, Wisconsin. Associate: Canadian Cutler-Hammer Ltd., Toronto.

Why Mill Men Prefer the Cutler-Hammer 505

Only ten major components; the ultimate in simplicity.

Over-the-wheel pull rod avoids clutter and trouble of complex linkage systems.

Single capsule operating coil easily accessible; reversible to put leads on either side.

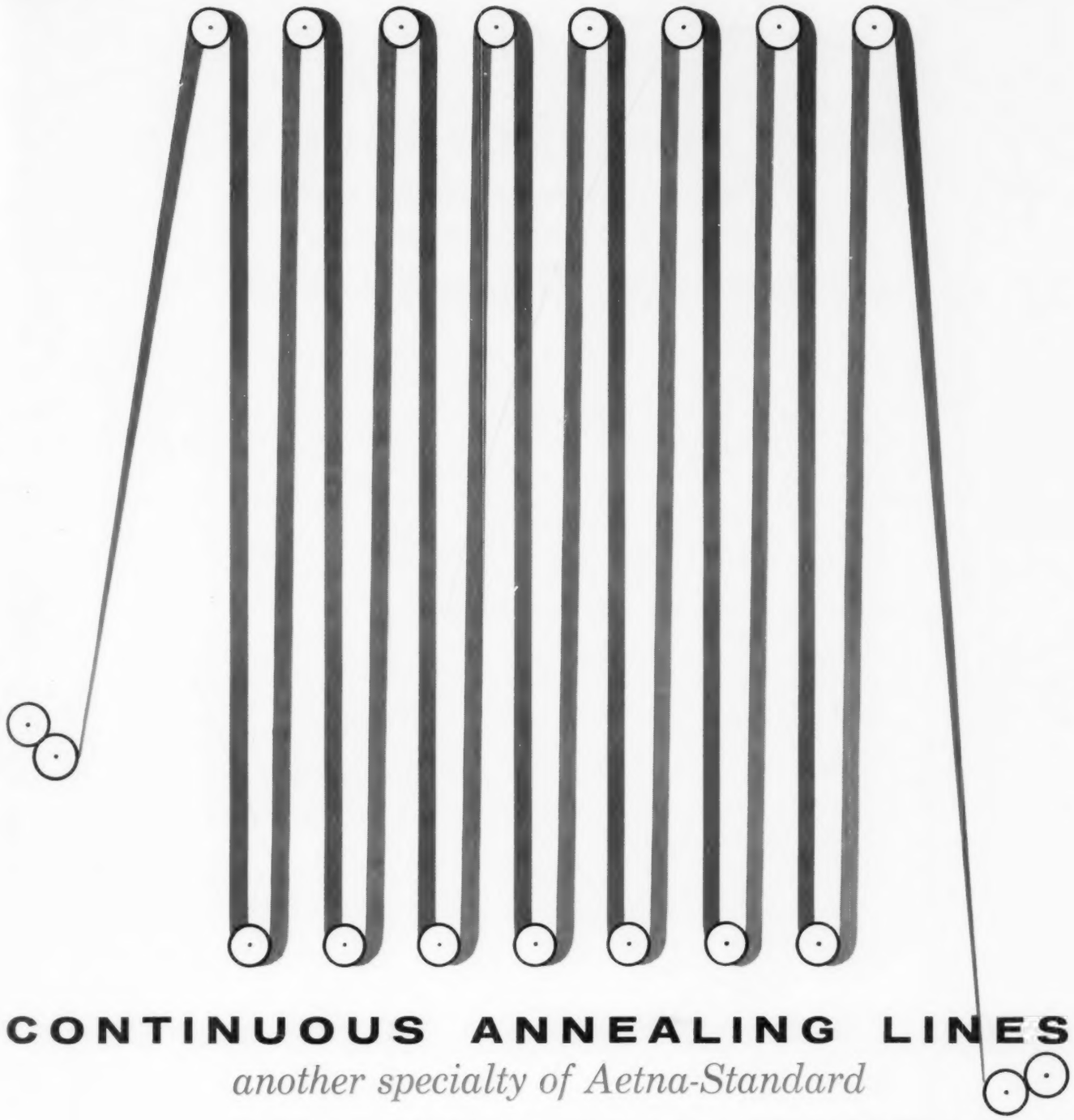
Shoes can be adjusted perfectly in total darkness by simply feeling the positions of indicating pins.

Single torque spring means only one torque adjustment.

Nuts for all adjustments are above the center line of the motor shaft; nothing is buried or hard to reach.

CUTLER-HAMMER
MOTOR CONTROL
C-H

IRON AND STEEL ENGINEER; is published monthly by Association of Iron and Steel Engineers at 20th and Northampton Sts., Easton, Pa. Editorial and advertising offices, 1010 Empire Bldg., Pittsburgh 22, Pa. Second-class mail privileges authorized at Easton, Pa.



CONTINUOUS ANNEALING LINES

another specialty of Aetna-Standard

Like Continuous Galvanizing or Tinning, a Continuous Annealing Line requires good designing and rugged equipment.

Aetna has much experience in continuous processing lines, galvanizing, tinning and annealing. In fact, Aetna pioneered in continuous equipment. Two of the most recent high speed Aetna lines incorporate many new ideas and innovations, permitting sure tracking at high speeds of 1,000 feet and more.

What can Continuous Annealing do for your production and your costs? Aetna's sales engineers can produce some interesting figures.

AETNA • STANDARD

THE AETNA-STANDARD ENGINEERING COMPANY

GENERAL OFFICES: PITTSBURGH, PA. • PLANTS: ELLWOOD CITY, PA., WARREN, OHIO • RESEARCH LABORATORY: AKRON, OHIO

CONTINUOUS GALVANIZING LINES • CONTINUOUS ANNEALING LINES • CONTINUOUS ELECTROLYTIC TINNING LINES • SIDE TRIMMING AND SHEAR LINES AND OTHER FINISHING EQUIPMENT • CONTINUOUS BUTT WELD PIPE MILLS • SEAMLESS TUBE MILLS • DRAWBENCHES AND OTHER COLD DRAW EQUIPMENT • ROLLS AND CASTINGS • EXTRUDERS, MILLS, PRESSES FOR RUBBER AND PLASTIC

No Excessive Heating

New Rectifier Cooling System Prevents Heat Build-up and Damage

when ac Power Fails

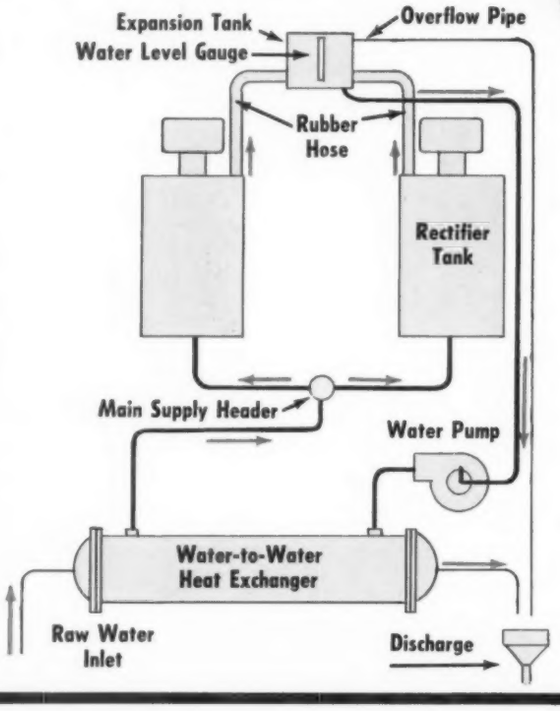
A SAFER, more effective cooling system in the Allis-Chalmers rectifier continues to circulate water *even when an ac power failure stops the water pump.* Heat and steam are dissipated before they can develop to the danger point.

The new system features an expansion tank that extends the full length of the rectifier frame with short vertical connections from each tube. With warm water continuing to flow freely upward, a thermo-siphoning action draws cooler water into the tubes. Build-up of excessive temperatures is prevented. Steam pockets are kept from forming. Subsequent water loss from the recirculating cooling system is minimized.

Successful operation in hundreds of installations is your assurance of the complete reliability of Allis-Chalmers mercury arc rectifiers. Contact your nearby A-C office or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wis.

How the System Works

Water is normally pumped through the water-to-water heat exchanger to the main supply header from where it circulates through rectifier tubes picking up heat. Hot water flows up through the short connections to expansion tank and back down to suction side of water pump.



ALLIS-CHALMERS Mercury Arc Rectifiers

Factory-packaged units cut installation time and costs. Sealed tube rectifiers are supplied in completely enclosed or open types. Here is a typical, completely enclosed, 1000-kw, 250-volt rectifier for steel mill service.

ALLIS-CHALMERS

A-5425

T. J. ESS, *Editor*
I. E. MADSEN, *Associate Editor*
W. C. FRIESEL, *Advertising Manager*
T. A. KOCIS, *Production Manager*

Board of Directors

PRESIDENT
LEONARD LARSON
Chief Engineer
Cleveland Works, Republic Steel Corp.

FIRST VICE PRESIDENT, EMIL KERN, *Vice President of Engineering,* Allegheny Ludlum Steel Corp.

SECOND VICE PRESIDENT, S. C. READ, *Director, Construction and Maintenance,* Jones & Laughlin Steel Corp.

TREASURER, C. E. PRITCHARD, *Superintendent of Mills,* Alan Wood Steel Co.

SECRETARY, H. L. JENTER, *Vice President-Operations,* American Steel and Wire Div., United States Steel Corp.

PAST PRESIDENTS: W. H. COLLISON, *Plant Superintendent,* Blast Furnaces and Coke Plant, Great Lakes Steel Corp.

J. D. O'ROARK, *Assistant Manager,* Department of Service and Maintenance, Electric, Weirton Steel Co.

DIRECTOR-AT-LARGE: C. W. BRUCE, *Chie Engineer,* Steel Plants, Republic Steel Corp.

DIRECTORS: F. B. BEVELHEIMER, *Power & Fuel Engineer,* Jones & Laughlin Steel Corp.

E. C. THOMAS, *Works Manager,* Pacific States Steel Corp.

J. R. POWELL, *Cleveland Works Manager,* Jones & Laughlin Steel Corp.

A. M. CAMERON, *Superintendent,* Blooming & Bar Mills, Atlas Steels, Limited.

C. A. BAILEY, *Lubrication Engineer,* National Tube Div., United States Steel Corp.

H. R. KNUST, *Assistant General Manager,* Sparrows Point, Bethlehem Steel Co.

A. KRAUSE, *Manager,* Rolling Mill Plant, Steel Div., Ford Motor Co.

W. T. PURVANCE, *Geneva Works Engineer,* Columbia-Geneva Steel Div., United States Steel Corp.

W. D. REES, *Superintendent,* Bar & Blooming Mill, Sharon Steel Corp.

J. E. BODOH, *General Supervisor-Electrical,* Gary Steel Works, United States Steel Corp.

S. O. EVANS, *Manager of Tubing Operations,* The Babcock & Wilcox Co.

F. H. WICKLINE, *Assistant Chief Engineer,* National Tube Div., United States Steel Corp.

GEORGE H. SCHAEFFER, JR., *Superintendent of Electrical Dept.,* The Carpenter Steel Co.

P. W. PHENEGER, *Administrative Vice President,* The Pollak Steel Co.

R. J. TREMBLAY, *General Manager,* Los Angeles, Bethlehem Pacific Coast Steel Corp.

A. S. MERROW, JR., *Assistant Fuel Engineer,* Bethlehem Stcel Co.

A. W. SCHLECHTE, *Chief Electrical Engineer,* Granite City Steel Co.

H. B. BUCKINGHAM, *Electrical Engineer,* Tennessee Coal and Iron Div., United States Steel Corp.

Managing Director
T. J. ESS
Empire Building, Pittsburgh, Pa.

Iron AND Steel ENGINEER

Volume XXXV · Number II **FEBRUARY 1958**

73 Recent Developments in Slabbing Mills
by H. J. Kalberkamp

82 Techniques in Rebuilding a Blast Furnace
by C. F. Bessent

95 High Velocity Gas Stress Relieving Furnace
by Edward M. Yard

102 Primary Roll Neck Bearings and their Protection
by George Sackerson

111 Power Layouts in Steel Mills
by A. J. Mosso

123 Tentative Program, AISE Spring Conference

124 Seamless Tube Making by the Calmes Process
by Dr. Albert Calmes and Clyde A. Roberts

133 European Steelmaking Today
by Alastair McLeod

160 Relationship Between Scleroscope, Rockwell and Brinell Hardness Readings
by N. R. Arant and J. J. Marsalka

162 Current AISE District Section Meeting Notices

164 J & L Starts Operation of 44-in. Mill at Aliquippa

173 Truck of Special Design Used in Roll Changing

174 Split Wind Blowing Increases Furnace Production

DEPARTMENTS

11 Crops and Shorts
23 Patent Reviews
183 Date-line Diary
191 Industry News
201 Publication Service
209 Personnel News
227 Equipment News
240 Book Reviews
255 Index to Advertisers

Published Monthly by

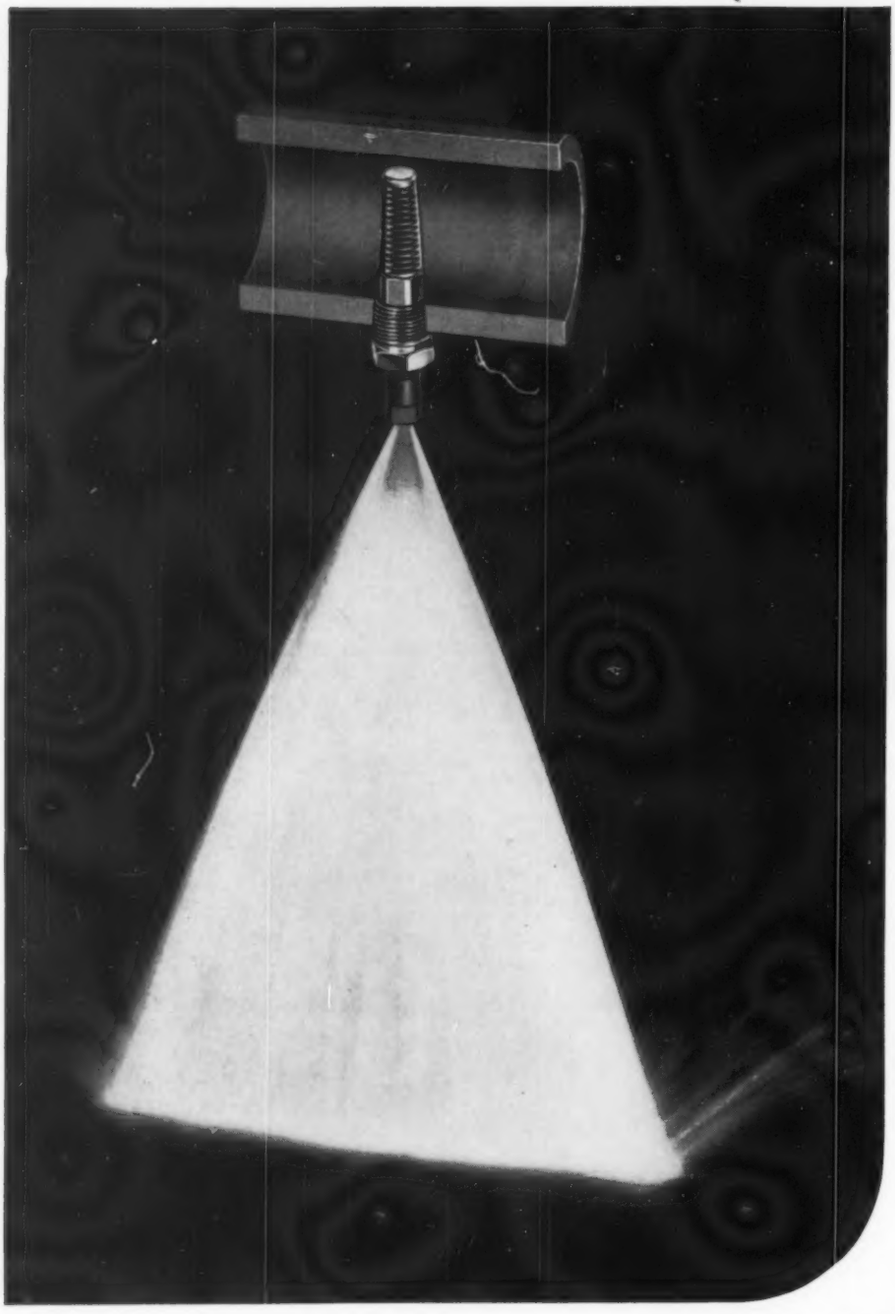
ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING PITTSBURGH 22, PENNSYLVANIA

Statements and opinions given in articles and papers appearing in "Iron and Steel Engineer" are the expressions of contributors, for which the Association of Iron and Steel Engineers assumes no responsibility.

Copyright, 1958, The Association of Iron and Steel Engineers.

Indexed by Engineering Index and by Industrial Arts Index.

Single Copy Foreign Prepaid $2.00 (U. S. funds) Single Copy $1.50
Subscription price in U. S. and Canada (U. S. funds) ..... $ 7.50 per year
Subscription price in foreign countries (U. S funds) ..... $10.00 per year



SPRAYING SYSTEMS

descaling NOZZLES

with open, elliptical non-clogging orifice

for performance *in full measure*

you can SEE the difference

When you consider performance in all its aspects, here are spray nozzles for descaling that give outstanding full measure. Descaling itself is carried out with an efficiency as high as or higher than any other nozzle made. But equally important, Spraying Systems nozzles give you low first cost . . . **plus non-clogging design** that **reduces** the cost of down-time and maintenance to a minimum.

The thin, concentrated, uniform spray strikes with greatest possible impact for any volume and pressure . . . descales without excessive sheet cooling.

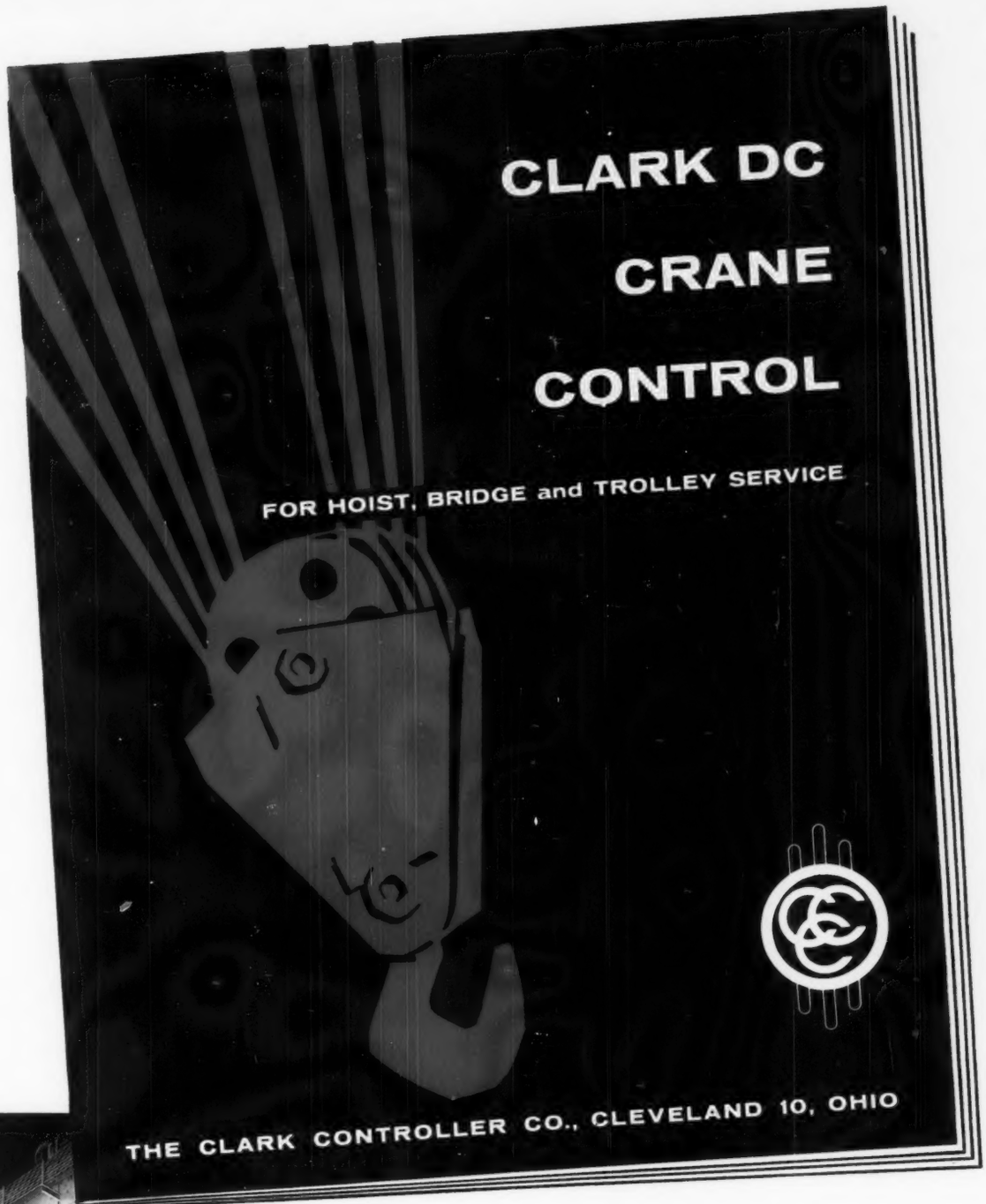
Clogging is practically eliminated by *elliptical*-shaped orifice . . . foreign matter goes right through.

CHOICE OF SIZES . . . offered in 16 different capacities . . . for every known descaling use.

Designed and manufactured by America's leading producers of industrial spray nozzles. For complete information write for Data Sheet 6120.

SPRAYING SYSTEMS COMPANY 3262 Randolph Street • Bellwood • Illinois

Spray Nozzles also supplied for such applications as Run-Out Table Cooling . . . Roll Cooling . . . Cooling Ingot Molds and many other uses. For complete information write for Catalog No. 24.



Clark has engineered and built control systems for all sizes and types of DC cranes, covering all five NEMA I.C1-42.01 Service Classifications. The hot ladle crane illustrated is an example of Group V, Steel Mill and Heavy Industrial.

Interested in DC Cranes?

This 20 page book outlines the basic principles of DC crane control, and provides the essential technical information you should have to select the controls best suited to your particular DC crane requirements. Profusely illustrated with photographs, charts and diagrams, the book explains in detail the circuits and components required for safe, dependable crane operation. As a major supplier of DC control of all types for over 30 years, The Clark Controller Company has pioneered and developed many of the advancements in modern DC crane control. This book provides an authoritative report of these developments.

Write today for your copy of this informative book. Ask for Bulletin 9100.

The CLARK CONTROLLER *Company* 11G

Everything Under Control 1146 East 152nd Street • • Cleveland 10, Ohio

IN CANADA: CANADIAN CONTROLLERS, LIMITED • MAIN OFFICES AND PLANT, TORONTO

ALL AROUND THE WORLD . . . strip coil producers prefer Lee Wilson high convection annealing furnaces

Great Britain, Canada, Sweden, Australia, Japan, Germany, Brazil, Mexico, Chile, Belgium, Luxembourg, France, Spain—wherever steel is made—you'll find the number one annealing furnace to be Lee Wilson's efficient Single Stack High Convection unit.

The world over, steel engineers know that no other furnace can deliver the uniformity and quality, the speed and low operation cost of the versatile Single Stack.

When next you're considering annealing equipment isn't it just good business to talk first with the world's leading furnace builders—Lee Wilson's engineers?

Lee Wilson* **ENGINEERING COMPANY, INC.**

20005 WEST LAKE ROAD • CLEVELAND 16, OHIO

SINGLE-STACK RADIANT TUBE ANNEALING FURNACES

MAKE THE BEST METALS BETTER

* ORIGINATORS AND LEADING PRODUCERS OF SINGLE-STACK RADIANT TUBE FURNACES

BIRDSBORO ROLLS...

. . . are a sum total of manual skill, metallurgical technique and technical manufacturing controls. The complete line includes many major roll types, subdivided into distinct analyses to meet a variety of job requirements. *Main Office, Engineering Department and Plant:* Birdsboro, Pa., *District Office:* Pittsburgh, Pa.

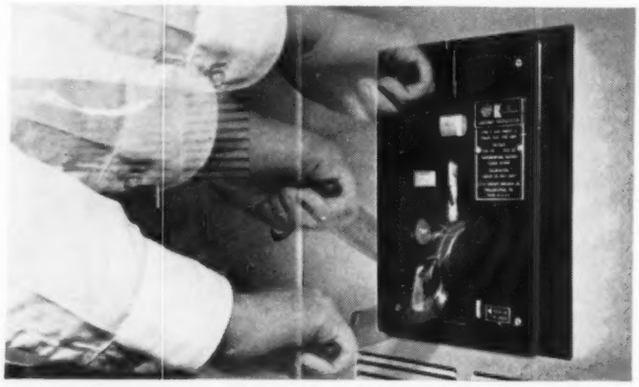
BIRDSBORO
STEEL FOUNDRY AND MACHINE CO.

STEEL MILL MACHINERY • HYDRAULIC PRESSES • CRUSHING MACHINERY • SPECIAL MACHINERY • STEEL CASTINGS • Weldments "CAST-WELD" Design • ROLLS: Steel, Alloy Iron, Alloy Steel

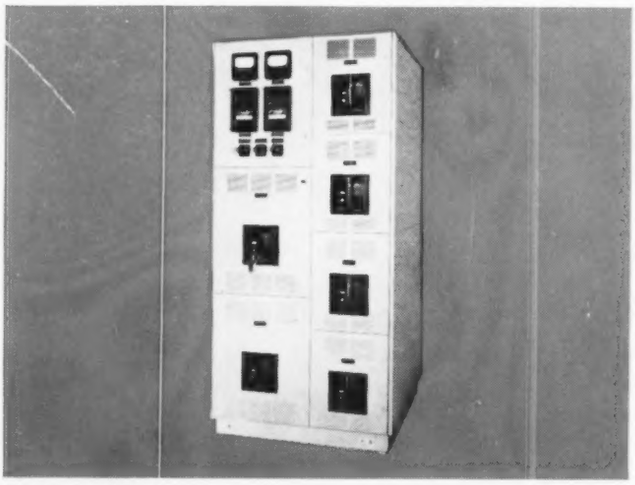
I-T-E makes sweeping design advances in new low voltage power circuit breakers, switchgear

I-T-E's new K-Line offers better performance, greatly simplified operation and servicing, and standardization in construction and assembly

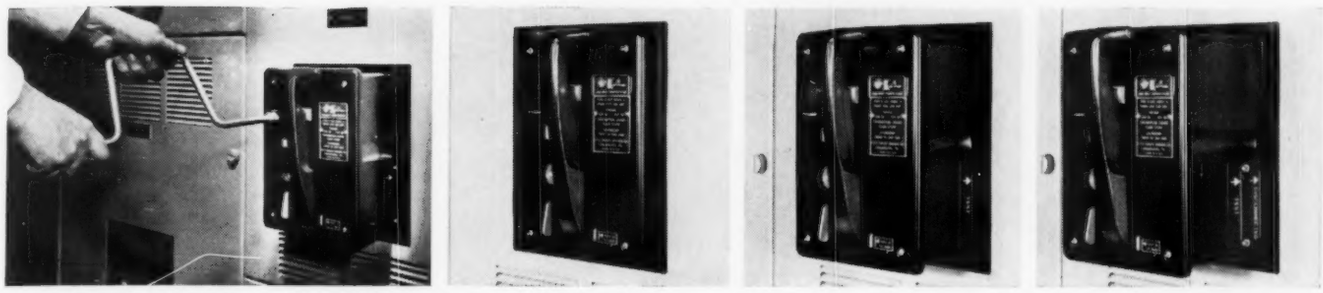
Now we offer a complete new design of equipment for the switching, control and protection of motor, generator, transformer and feeder circuits, as well as other large electrically powered facilities—the most sweeping design advance in 13 years. Among the major innovations in the new design are the following.



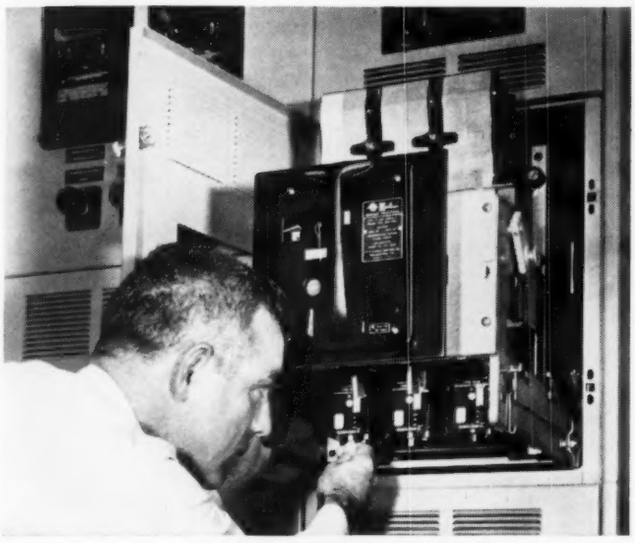
First quick-make manually charged stored energy closing mechanism. First 90% of pulldown handle travel charges spring mechanism, last 10% releases stored energy, automatically closes contacts. No teasing of contacts is possible.



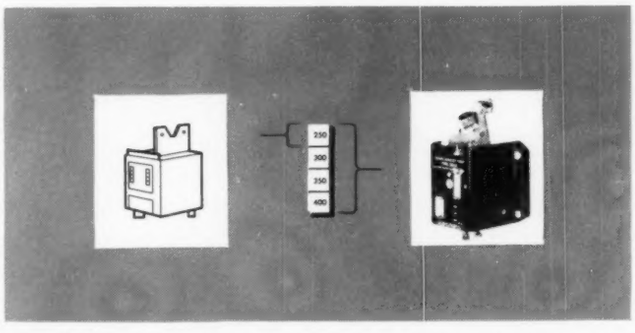
4-high stacking of 600 amp frame size circuit breakers in 90-in.-high enclosures. The new circuit breakers are as much as one-third smaller and 55% lighter than comparable units. The new switchgear is the smallest ever designed.



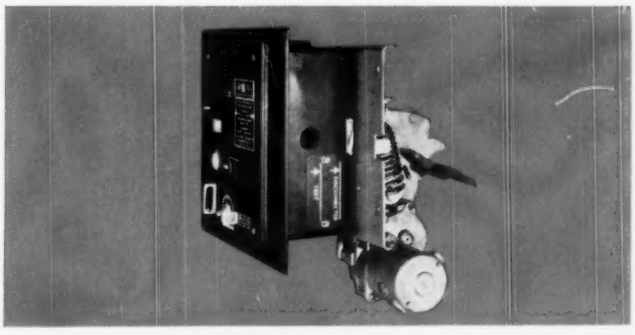
First closed-door drawout of circuit breakers. This permits racking of circuit breaker into connected, test and disconnected positions without opening the door of the circuit breaker compartment. Drawout arrangement keeps circuit breakers clean, aisles uncluttered, promotes personnel safety. Breaker must be opened before shutter can be lifted to insert drawout racking crank. Breaker cannot be closed while shutter is lifted.



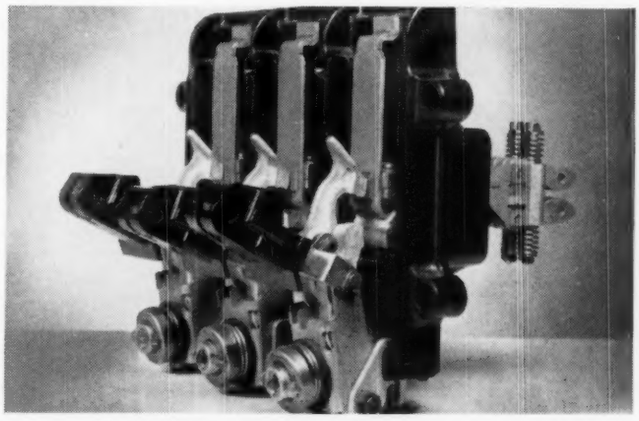
Greatly increased accessibility to component parts for operation and servicing. For example, trips on electrically and manually operated breakers are out in the open and can be easily adjusted. Trips also can be changed quickly. One-piece molding holds trip units, which are changed from the rear and in a fraction of the time formerly required.



Expanded trip flexibility meets last-minute load changes in many instances with the existing trip unit.



Stored energy electrical closure that materially cuts control circuit requirements. The motor-driven stored energy system requires only 10 amp from a simple power source, compared to as much as 160 by comparable solenoids. Quick-make manual closure operates on same principle. First 90% of pull-down handle travel charges a spring mechanism. Last 10% releases the stored energy and closes the contacts. No teasing.



Subassembly circuit breaker construction permits easier, faster replacement of parts. Six major subassemblies replace 130 separate parts in previous models. A part replacement formerly requiring an all-day overhaul of the circuit breaker may mean only removing and replacing a unit subassembly—a matter of minutes.

Bulletin 6004C tells the complete story of this advanced design switchgear. Ask your local I-T-E representative for a copy today. Or write I-T-E CIRCUIT BREAKER COMPANY, Switchgear Division, 19th & Hamilton Sts., Philadelphia 30, Pa.

I-T-E

I-T-E CIRCUIT BREAKER COMPANY

19TH AND HAMILTON STREETS, PHILADELPHIA 30, PENNSYLVANIA

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

5031 EAST 289th ST.
WICKLIFFE, OHIO

Crops *and* Shorts

△ The steel industry has become somewhat sensitive about the expression of its operating rate in terms of per cent of capacity. With capacity constantly increasing and with production currently reduced, the percentage figure is, of course, doubly affected. The American Iron and Steel Institute is emphasizing the rather obvious fact that tonnage is the true measure of conditions. Certainly, this is the only figure that can be used in comparative work. They also report an index figure which compares current production with that of a three-year (1947, 1948, 1949) average. This is one of those figures in which government economists revel, and might be all right for them. We believe, however, that the current operating rate in per cent of capacity will still be with us, not for long range comparisons but as the answer for the perennial "How ya' doin?"

△ It was nice to see a glimmer of statesmanship in labor union management when Richard J. Gray, president of The Building Trades Department of AFL-CIO told the department's convention that a moratorium on wage increases in 1958 would be a major step in the war against inflation. Unfortunately, no other labor leader agreed with him.

To the contrary, David J. McDonald, president of United Steel Workers, came forth with the idea of an extra three-month or longer vacation every five years, and Walter Reuther, president of United Auto Workers, suggested an intricate profit-sharing split with workers and customers. True, these pronouncements are primarily only publicity grabs and trading goods, but they indicate how far the thinking is from moratoriums.

△ Economy might have become an obsolete word if it hadn't been adopted to describe a large-size package.

△ Official figures from The American Iron and Steel Institute give 1957 steel production at 112,707,711 net tons, third highest in history.

Annual capacity of the industry as of January 1, 1958, is 140,742,570 tons of ingots, made up of 122,321,830 tons from open hearths, 13,312,740 tons from electric furnaces and crucibles, 4,027,000 tons from bessemer converters and 1,081,000 tons from oxygen converters. Blast furnace capacity is set at 91,000,110 net tons per year, and coke at 72,198,260 net tons per year, including 70,452,660 tons from by-product ovens and 1,745,600 tons from bee-hive ovens.

△ What with tax time again upon us, the newspapers present some interesting contrasts. A single issue recently carried a lengthy story pointing out and deploring all the loop-holes in our income tax structure, and three other items:

A suggestion to allow taxpayers to deduct any increase in state and local school taxes in full from their federal income tax bill.

A suggestion to permit taxpayers to reduce final tax bills by 90 or 100 per cent of all contributions made for basic scientific research at colleges and universities.

A suggestion to allow farmers forced to sell farms through condemnation to buy income-producing property other than farms without paying taxes on profits from the sale of the farm.

△ It all depends on whose foot the shoe pinches. The Field Representatives Federation, an organization of labor organizers, presented a grievance to their employer, the AFL-CIO. It seems some of the organizers are being let out and their Federation says AFL-CIO is guilty of "anti-union behavior" and is trying to destroy the Federation. AFL-CIO did not favor the formation of the Federation.

△ Steel products were imported into the United States in 1957 at a rate of about 109,000 tons per month, approximately 6 per cent above 1956. Structural shapes, steel pipe, reinforcing bars and wire were the major items. On the other hand, the United States exported about four times that tonnage.

△ President Eisenhower's proposal for 10,000 undergraduate scholarships annually for the next four years is being criticized in various quarters. It is felt that student recruitment is not as much a problem as is maintenance of adequate facilities and faculty for education in engineering and science. The added burden set up by the scholarships would aggravate the already serious plight of many schools.

Furthermore, there is serious doubt in some quarters that talented youths are deprived of higher education. The National Merit Scholarship Corp. recently checked on 4226 individuals who did not receive merit scholarships in 1956 because funds were not available. Of this group, 73 per cent answered the query; 65 per cent of these had received some other scholarship help and another 27 per cent had received other forms of financial aid. Only 40 reported they were not attending college. Of the 40, 19 expected to attend in the near future, having been delayed by military service, illness, accidents, family problems, etc.

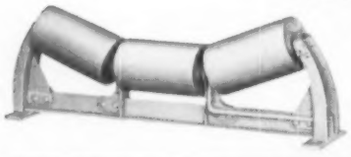
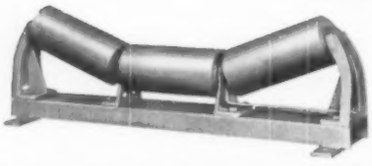
There is also the belief that developments such as guided missiles, space satellites, etc., depend on highly advanced technology, demanding quality rather than quantity in the people so employed.

△ Unwillingness to share the work is a bad result cropping out of supplemental unemployment benefits. The United Auto Workers requested the Caterpillar Tractor Co. not to go to a four-day work week, but to lay off some employees or shut down the entire plant temporarily. The union accused the company of seeking to avoid paying unemployment benefits.

△ It's interesting to note that the recent Chicago auto show displayed 20 makes of domestic cars and 28 makes of foreign cars.

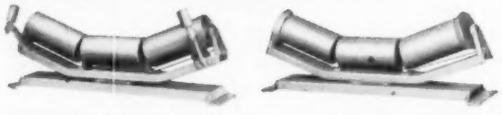
MATCH IDLERS TO THE JOB

...LINK-BELT can meet your specific load and capacity requirements

IDLER SERIES	TYPE OF IDLER DUTY	TYPICAL APPLICATIONS
NEW 50	General duty conveyor • for maximum loads of 100 lbs. per cubic foot • for moderate lump sizes	Designed for conveyors carrying medium loads or for installations requiring intermittent operation.
100 	"Round-the-clock work horse" • handles all but the heaviest and coarsest materials	Coal, coke, sand, gravel, iron ores, sinter, taconite, potash.
200 	Rugged heavyweight • for continuous service • carries the heaviest and coarsest materials	Heavy ores, such as iron, copper, etc. . . . on conveyors employing high-capacity belts.

LINK-BELT SERIES 100 IDLERS on this 42-in. wide, 218-ft. long belt conveyor carry 800 tph of ore from primary screens to stock pile.

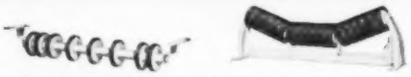
TO TRAIN YOUR BELTS for proper operation . . .



BELT TRAINING IDLERS Left, positive action type trains and protects single direction belts. Actuating disc type at right is best for reversible conveyors. Self-aligning idlers of both types are also available for return run.

RETURN BELT IDLERS support the empty belt on the return run.

TO PROTECT THEM IN SERVICE



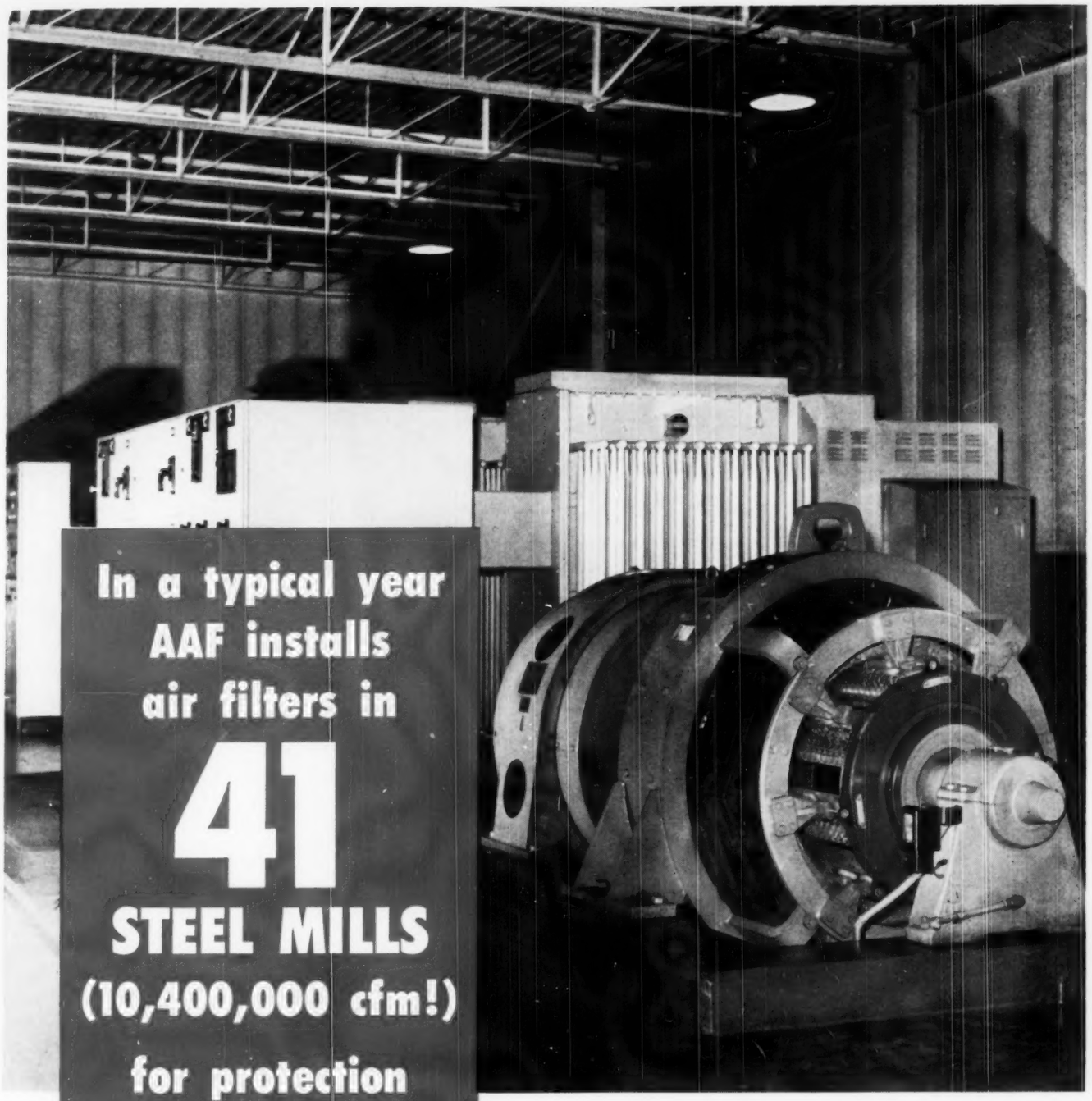
TROUGHED RUBBER CUSHION IDLERS (right) absorb impact under loading points, when large lumps and heavy materials are loaded on belt. Rubber tread return idlers, at left, simplify handling of tenacious materials.

WHETHER you handle cottonseed or coal—Link-Belt makes the exact size and type of belt conveyor idler you need. For top performance . . . lowest per-ton handling cost—see your nearby Link-Belt office or authorized stock-carrying distributor. Ask for Data Book 2416.

LINK-BELT

BELT CONVEYOR IDLERS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World. 14



In a typical year AAF installs air filters in

41

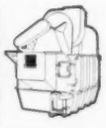
STEEL MILLS

(10,400,000 cfm!)

for protection of motor room equipment

HERE'S WHY: instead of making one or two kinds of air filters, AAF makes *all* kinds. This assures you that, no matter what filtration conditions you face, you get the *efficiency you need* plus the *maintenance characteristics you want!* Talk over your clean air needs with your local AAF representative.

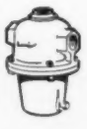
AAF Filters and Precipitators



AAF Dust Control Equipment

BETTER AIR IS OUR BUSINESS

Herman Nelson Unit Heaters



Illinois Heating Specialties

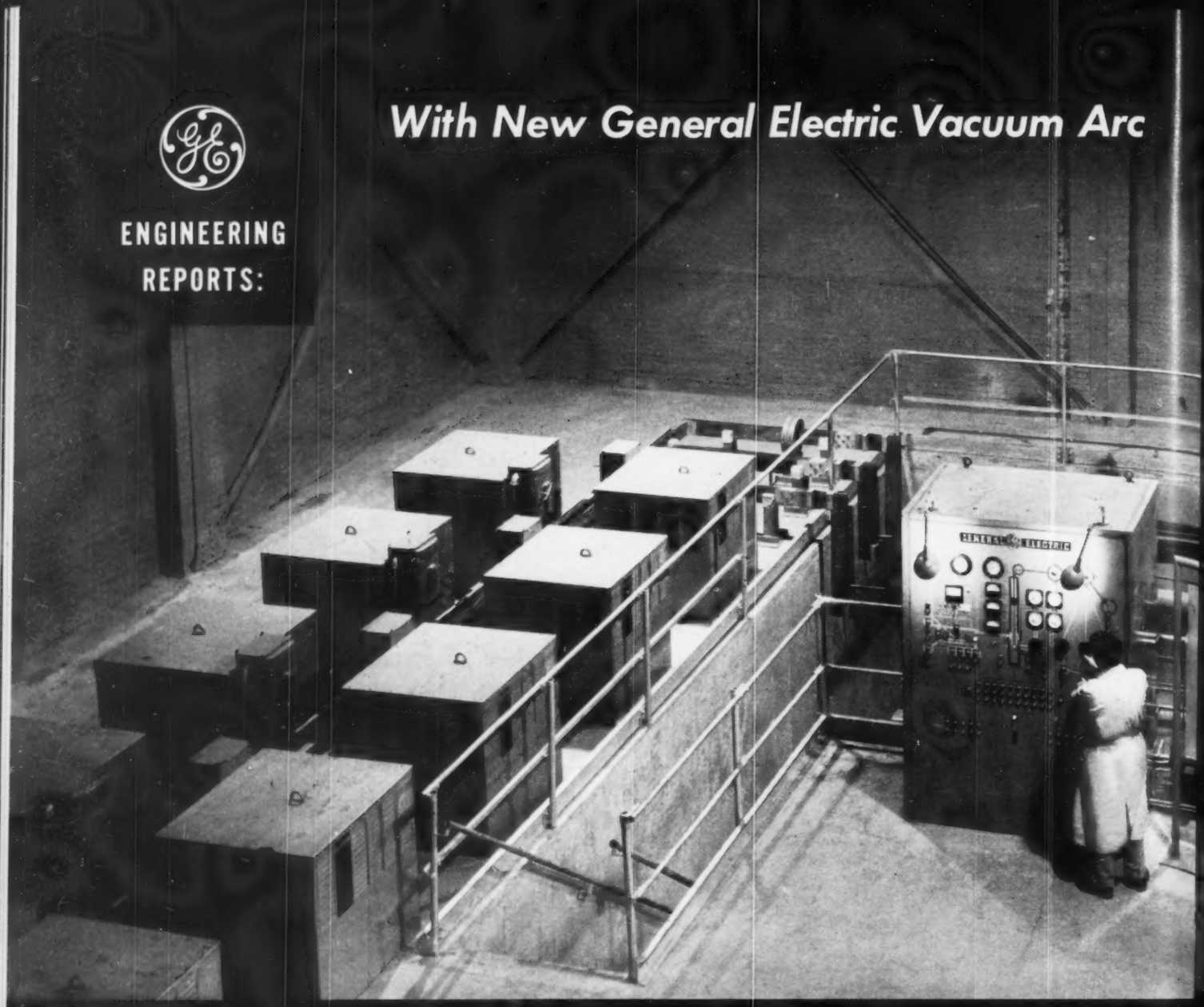
AAF — herman nelson

American Air Filter
COMPANY, INC.

302 Central Avenue, Louisville 8, Kentucky
American Air Filter of Canada, Ltd., Montreal, P. Q.

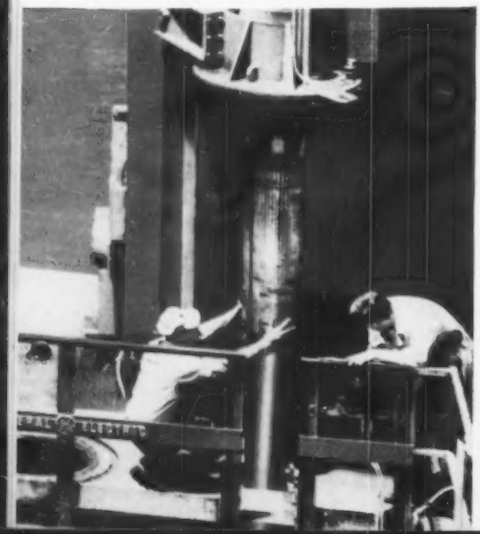
ENGINEERING
REPORTS:

With New General Electric Vacuum Arc



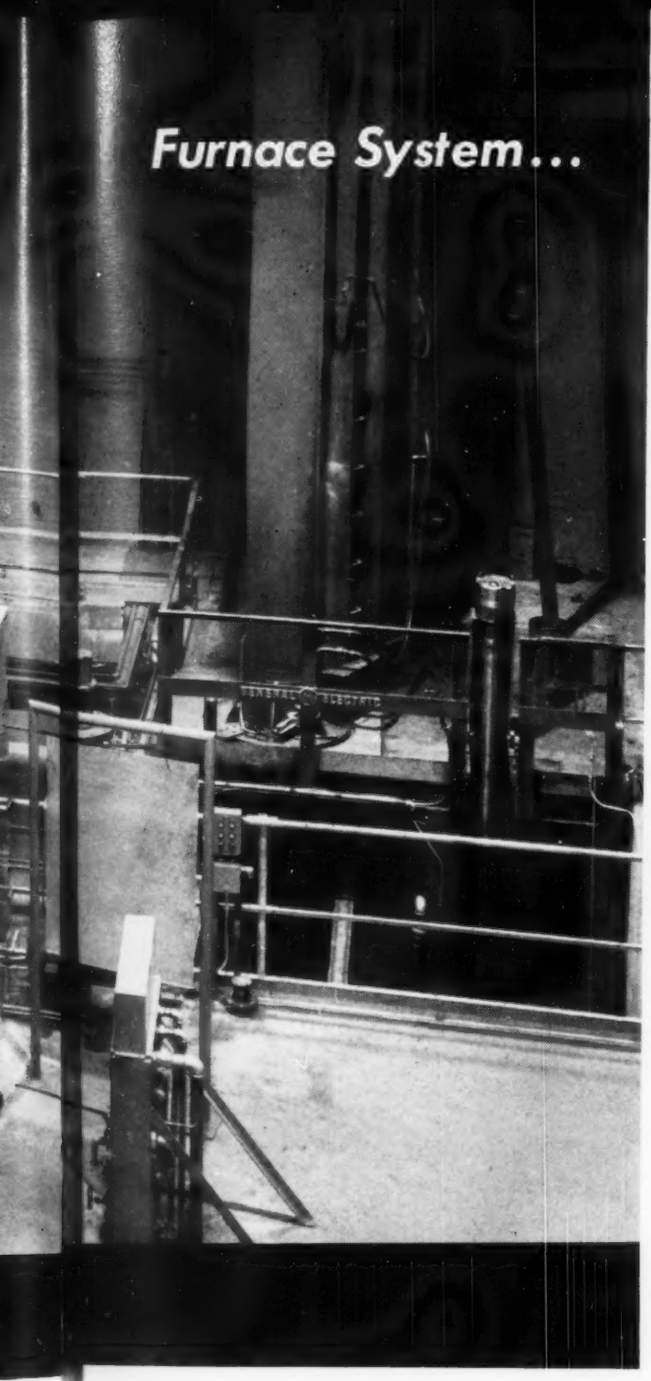
NEW APPROACH to vacuum arc furnace design is reflected in this G-E installation at Universal-Cyclops Steel. Unique current collector and electrode drive permitted a lowering in ceiling height required, helped reduce installation time and cost. G.E. offers a line of furnaces covering ingot sizes from 2½ to 30 inches in diameter, weights up to 25,000 pounds.

CURRENT COLLECTOR, being attached to electrode, provides a sliding contact—a basic G-E design improvement in vacuum arc furnaces.



ELECTRODE DRIVE SYSTEM, using amplidyne control of proven dependability, is another G-E improvement. Here, operator lowers electrode housing with electrode into furnace body.

COMPLETED molybdenum ingot, being stripped from crucible assembly, has pure, uniform-grain structure that permits faster machining.



Universal-Cyclops Steel produces high-purity Moly ingots

New current collector assembly reduces downtime between melts, eases handling of ingots and electrodes

To help produce molybdenum ingots of high purity for demanding applications, Universal-Cyclops Steel Corp. recently installed a General Electric vacuum arc furnace system in its Bridgeville, Pa. plant. Such production-type furnaces are capable of melting ingots 16 inches in diameter by 66 inches long and weighing up to 5500 pounds. They are designed and engineered by General Electric as co-ordinated systems, complete with all other electric equipment needed from incoming power line to furnace arc.

Successful from the first melt

The furnace's self-supporting, unit-type construction minimized installation time and cost. Successful operation was obtained from the first melt. And Universal-Cyclops officials are completely satisfied with the ease and safety with which the furnace can be operated. These results stemmed from many newly developed features of the furnace itself, plus G-E engineering assistance during installation and startup.

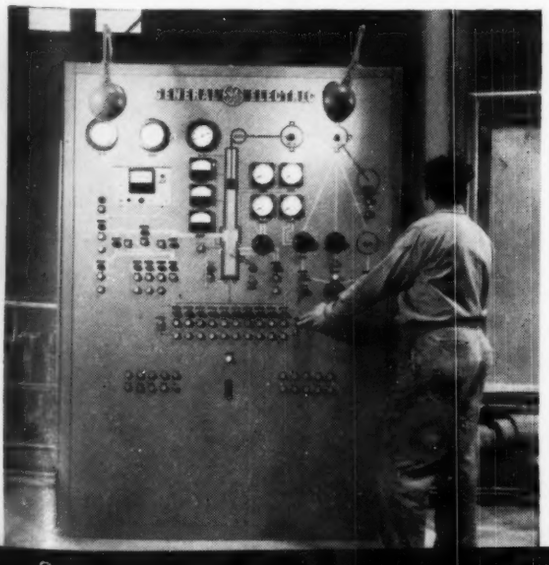
Loading operation simplified

For example, a unique current collector system, using a sliding contact, picks up the arc current from inside the electrode housing. This time-tested principle is similar to that of a d-c motor commutator. This permits raising and swinging the electrode housing to one side for loading, reducing ceiling height requirements, simplifying the loading operation and the handling of electrodes. It also permits using an accurate compact electrode drive system automatically controlled by means of the more dependable, instant-acting G-E amplidyne.

Engineering assistance available

General Electric engineering services are constantly at work in the development and design of even better electrical systems for the vacuum melting industry. For instance, General Electric has completed design of a new silicon rectifier power supply for use in vacuum arc furnace systems, and is prepared to furnish these systems to your industry. From design through application, manufacturing, installation and operation, these services are available to you. Contact your local G-E Apparatus Sales Office early in the planning stage. Meanwhile, send for Bulletins GER-1450 "How to Select a Vacuum Arc Furnace," and GED-3599 "Here's Why G.E.'s Vacuum Arc Furnace Is Your Best Buy" to General Electric Company, Section 659–119, Schenectady 5, N. Y.

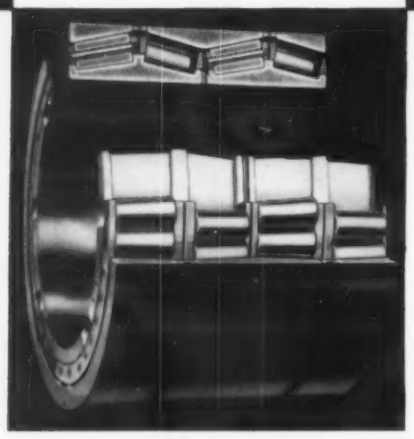
SYSTEM-DESIGNED G-E panel for effective control of entire operation contains instruments and devices for regulating arc voltage and current, furnace pressure, etc.



Engineered Electrical Systems for Steel Mills

GENERAL ELECTRIC

Pin-type retainer construction of Torrington Four-Row Tapered Roller Bearing provides maximum capacity in minimum cross section.



For Maximum Capacity and Life Expectancy
Torrington Roll Neck Bearings

In design, selection of materials and precision construction, Torrington spares no detail to insure maximum bearing capacity and life expectancy in roll neck bearings.

For example, where rolling mill window openings and roll diameters limit roll and bearing dimensions, Torrington design provides for minimum bearing cross section and maximum roll neck diameters. Rollers are longer and pin-guided to allow closer spacing and greater area of contact surface, providing a much greater load capacity.

Care in such details, and in proper selection of the *right* bearing for your application, pays off in tonnage rolled. For most satisfactory performance, make Torrington Bearings your selection. **The Torrington Company, South Bend 21, Ind.—and Torrington, Conn.**

TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

TAPERED ROLLER • SPHERICAL ROLLER • CYLINDRICAL ROLLER • NEEDLE • BALL • NEEDLE ROLLERS • THRUST

designed and built by . . .

UNITED®

HIGH SPEED
5-STAND
TANDEM COLD MILL

UNITED
ENGINEERING AND FOUNDRY COMPANY
PITTSBURGH, PENNSYLVANIA

Plants at Pittsburgh, Vandergrift, Youngstown, Canton, Wilmington

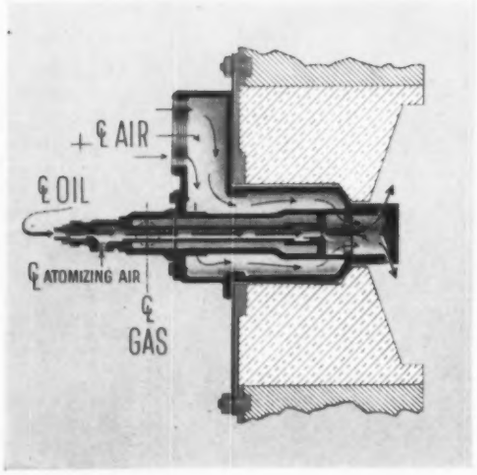
SUBSIDIARIES: Adamson United Company, Akron, Ohio
Stedman Foundry and Machine Company, Inc., Aurora, Indiana

Designers and Builders of Ferrous and Nonferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other heavy machinery. Manufacturers of Iron, Nodular Iron and Steel Castings and Weldments.

for intense concentration of heat . . .

The BLOOM HTR BURNER

The Bloom HTR Burner provides identical operation on either gas or oil.

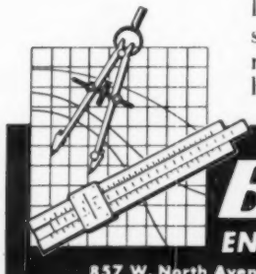


PATENT PENDING

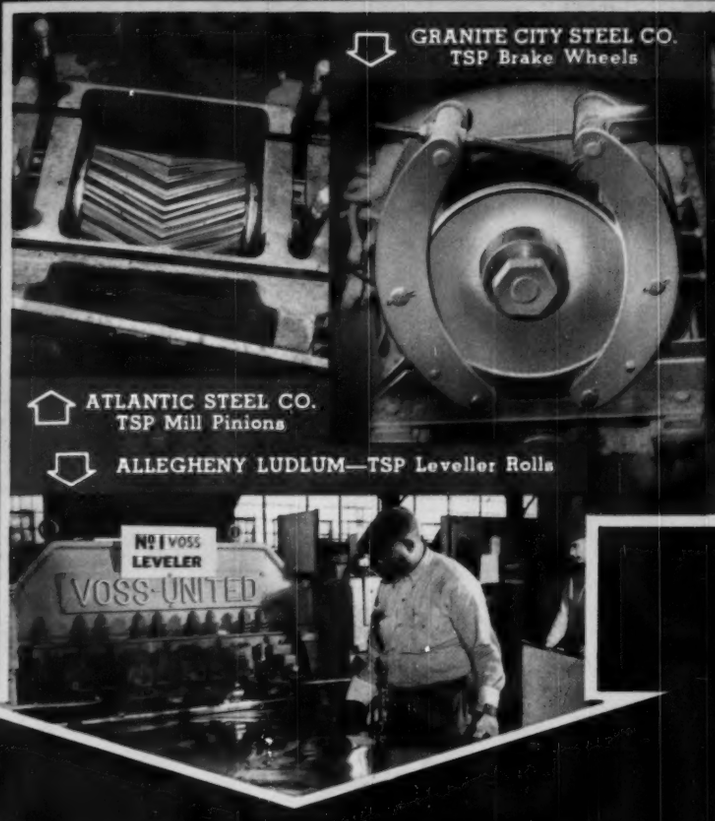
This burner enables the engineer to design a heat pattern with excellent results, because it has the unique characteristic of providing localized high heat release with low forward velocity. The burner can be located to fire directly at the material without flame impingement. Roof firing is easily accomplished and provides uniform hearth temperature.

This burner has been very successful in its application to tube upset furnaces; continuous strip annealing, coating, and pre-heating lines; high speed billet heating furnaces; and batch-type forge furnaces.

The Bloom High Thermal Release Burner with its sturdy construction is ideal for applications requiring speed and precision heating.



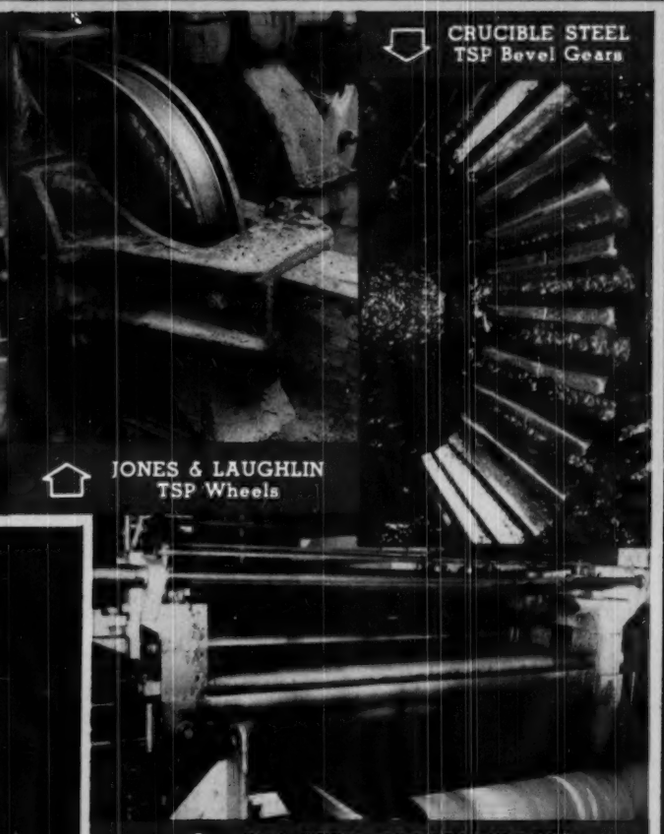
BLOOM
ENGINEERING CO., INC.
857 W. North Avenue Pittsburgh 33, Pa.



GRANITE CITY STEEL CO.
TSP Brake Wheels

ATLANTIC STEEL CO.
TSP Mill Pinions

ALLEGHENY LUDLUM—TSP Leveller Rolls



CRUCIBLE STEEL
TSP Bevel Gears

JONES & LAUGHLIN
TSP Wheels

U. S. STEEL, FAIRLESS WORKS
TSP Leveller Rolls

INLAND STEEL CO.
TSP Screwdown Screws

KAISER STEEL CORP.
TSP Pipe Forming Rolls

U. S. STEEL, FAIRLESS WORKS
Cold Rolling Rolls

U. S. STEEL, TENNESSEE COAL & IRON DIV.
TSP Mill Pinions

take a look at these TSP installations...

definite proof that long life "Tool Steel Process" hardened products are unequalled. Our long experience in the Steel Industry, our special production facilities, metallurgy and engineering — all combine to make TSP products the standard of quality—your best investment.

here's why: TSP products are hardened by our special process. The file hard surface to full depth of permissible wear gives maximum life. The core, refined for toughness and ductility, gives maximum strength. You receive an absolutely positive written guarantee that TSP products will give a longer life in the same service than any other product.

THE TOOL STEEL GEAR AND PINION CO.
CINCINNATI 16, OHIO, U. S. A.

AD No 1008

The World's Standard of Quality Since 1909 for
Gears • Pinions • Rolls • Wheels and Other Hardened Products

For Dust Collection . . .

Western Precipitation
presents
its latest development
in a quarter-century of
continuous advancement
in Mechanical Collectors

. . . The "9VGR" MULTICLONE!

Over 25 years ago

Western Precipitation Corporation pioneered the high-efficiency multiple-tube principle that has proven so superior it is now the pattern for the industry.

The Multiclone continues to be years *ahead* of all other centrifugal collectors because it incorporates the invaluable "know-how" gained through these many years of leadership in the field —leadership that is further emphasized by introduction of the 9VGR Multiclone, another important milestone in Multiclone's quarter-century of outstanding performance.

COTTRELL Electrical Precipitators
MULTICLONE Mechanical Collectors
CMP Combination Units
DUALAIRE Reverse-Jet Filters
HOLO-FLITE Processors

NEW 9VGR FEATURES . . .

1. *No need for continuous external support.*
2. *Easier and less costly to insulate.*
3. *Minimum dust stratification.*
4. *Improved dust distribution to all tubes.*
5. *Simpler installation, lower erection costs.*
6. *Freedom from leakage at all critical points so that full collection efficiency is obtained.*

Plus **The proven superiority of CAST IRON TUBES and VANES!**

Through the years, others have tried special alloy steels and so-called "miracle" metals, but nothing has proven as satisfactory *in actual field service* as cast iron. In the past quarter-century more than 270,000 Multiclone tubes have been placed in service with less than 1.85% replacement—*a performance record unequalled in the industry!*

There are many other advantages built into the 9VGR. There is a Multiclone representative near you who will be glad to supply complete details. Or write direct, asking for your free copy of Bulletin #M209 which contains full details.

Western Precipitation Corporation

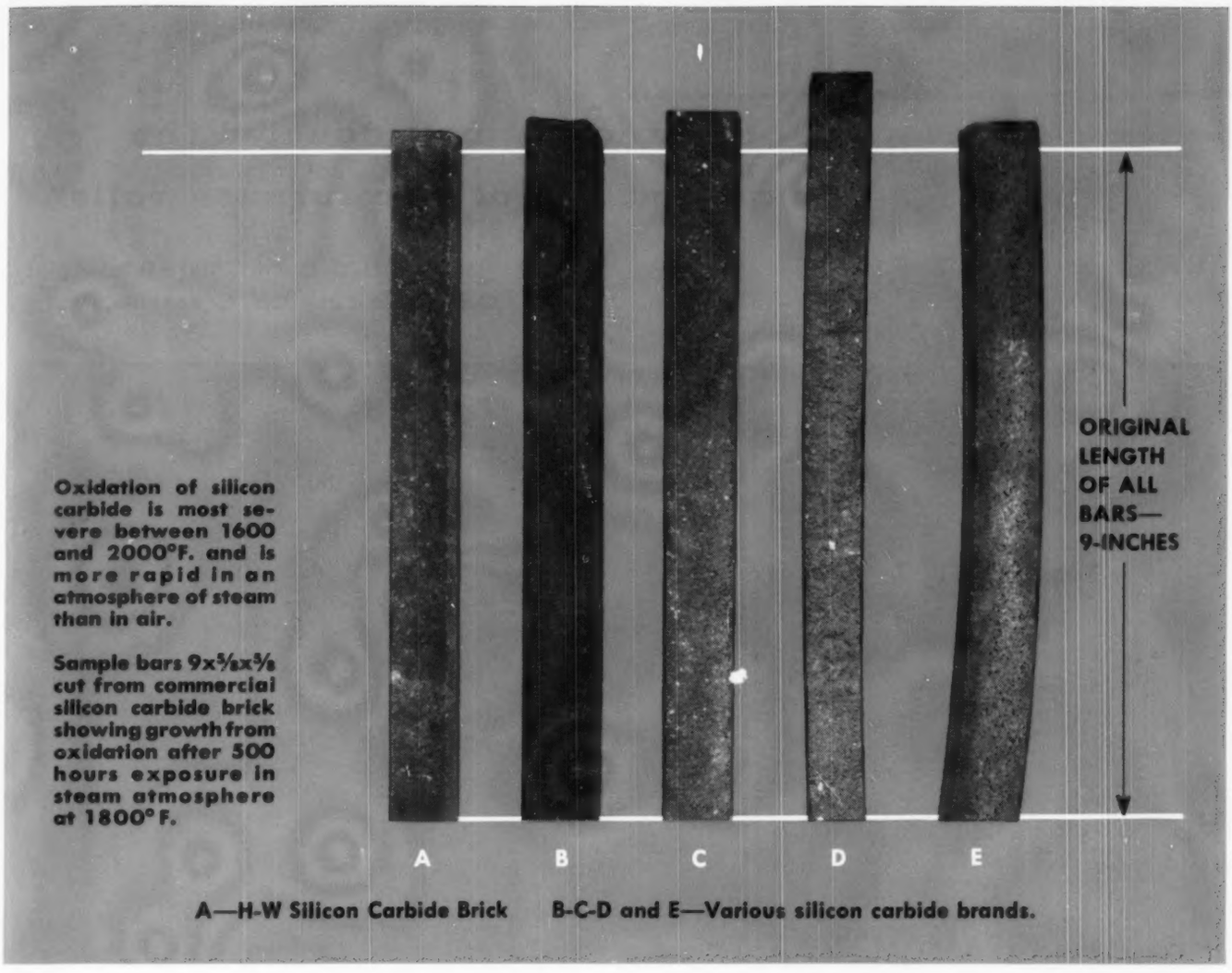
Designers and Manufacturers of Equipment for Collection of Suspended Material from Gases . . . and Equipment for the Process Industries

Main Offices: **1067 WEST NINTH STREET, LOS ANGELES 54, CALIFORNIA**

Chrysler Building, New York 17 • 1 North La Salle Street Building, Chicago 2 • Oliver Building Pittsburgh 22 • 3252 Peachtree Road N. E., Atlanta 5 • Hobart Building, San Francisco 4

Precipitation Company of Canada Ltd., Dominion Square Building, Montreal

Representatives in all principal cities


Oxidation of silicon carbide is most severe between 1600 and 2000°F. and is more rapid in an atmosphere of steam than in air.
Sample bars 9x⅝x⅝ cut from commercial silicon carbide brick showing growth from oxidation after 500 hours exposure in steam atmosphere at 1800° F.
ORIGINAL LENGTH OF ALL BARS— 9-INCHES
A
B
C
D
E
A—H-W Silicon Carbide Brick
B-C-D and E—Various silicon carbide brands.

Announcing

Silicon Carbide Refractories

made by HARBISON-WALKER

Some of the physical properties of major importance are measurably enhanced by developments in manufacturing procedures. Many sizes and shapes are formed by impact under great pressure resulting in the most homogeneous texture with higher density and strength.

High temperature firing in a closely controlled atmosphere contributes to the formation of an exceedingly impervious surface and lower permeability. These properties improve resistance to the objectionable oxidation which always is accompanied by volume increase and loss in strength.

Physical properties possessed to the *maximum degree* by H-W Silicon Carbide refractories make them best suited for many applications. Briefly these properties are—Thermal Conductivity—Resistance to Mechanical Abrasion over a wide range of temperatures—Resistance to various fluxes—High temperature strength—Low Thermal Expansion and Low Spalling Tendency.

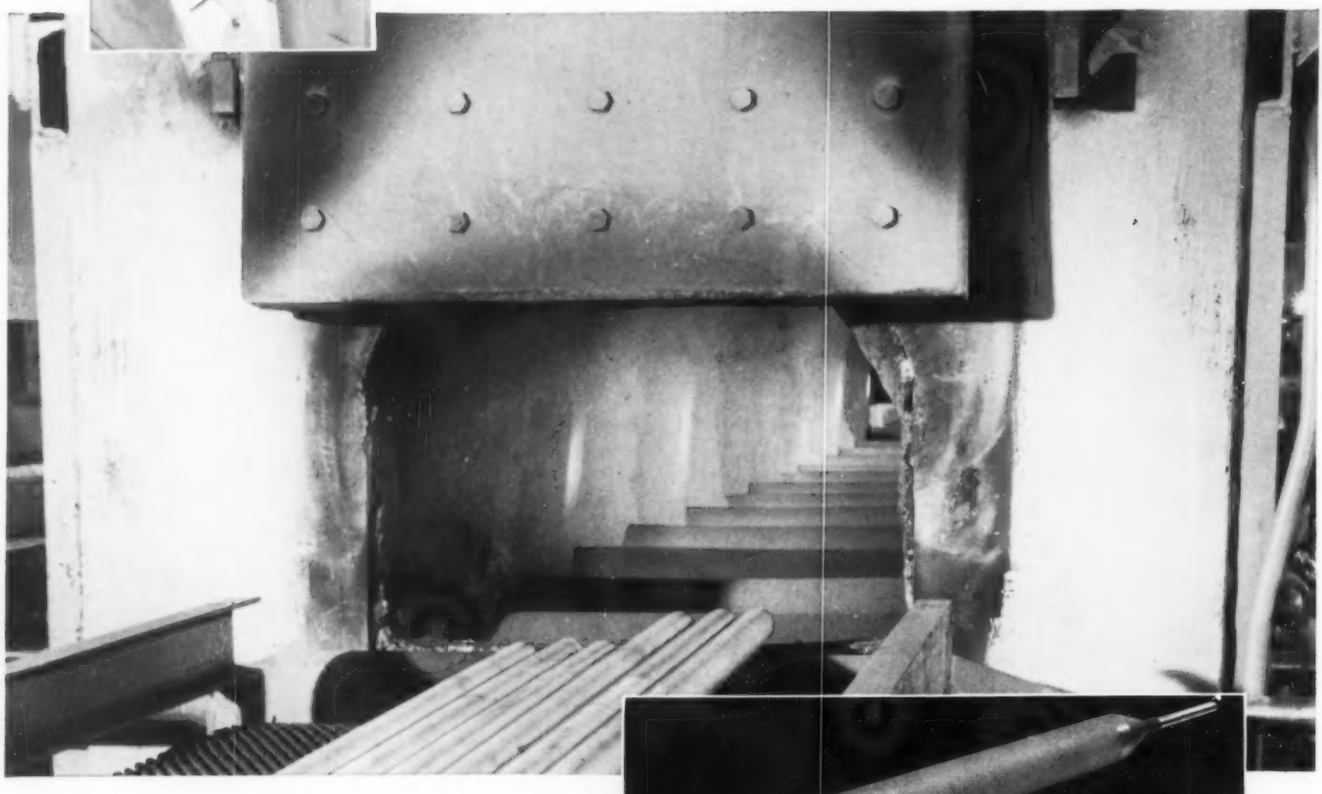
Write for recommendations and technical assistance.

World's Most Complete Refractories Service

HARBISON-WALKER REFRACTORIES COMPANY
AND SUBSIDIARIES
General Offices: **Pittsburgh 22, Pennsylvania**

"We more than doubled the expected life of our furnace rolls"

Says Mr. B. B. Burd, Chief Metallurgist
Damascus Tube Co., Greenville, Pa.



Damascus solution-anneals stainless steel welded tubing.

"When we installed Thermalloy* cast furnace rolls, we estimated the service life on the basis of operating temperature of 1950° to 2150° F.

After more than double the expected life, our Thermalloy rolls show no sign of wear and are still operating at peak efficiency!

"I feel the chief reason for this successful service is the careful selection of alloys and the design of the furnace rolls.

"We also employ a maintenance program to further extend the life of the rolls. At the advice of Electro-Alloys, we never completely shut down the furnace. On week ends we maintain the temperature at 1400° F. and keep the rolls turning at idling speed. This reduces the temperature gradient and offsets distortion possible when the rolls are not turning."

Whatever *your* heat-treat problems, Electro-Alloys has the experience necessary to help you solve them. Call your representative — or write Electro-Alloys Division, 9061 Taylor Street, Elyria, Ohio.

*Reg. U. S. Pat. Off.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION Elyria, Ohio

patent reviews

By MELVIN NORD, Patent Attorney, Detroit, Mich.

Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents . . . . patents reviewed cover period September 3, 1957 through September 24, 1957.

METHOD OF CONTROLLING THE PARTIAL BLOWING OF BESSEMER STEEL

△ U. S. 2,807,537, issued Sept. 24, 1957 to Donald W. Murphy, assigned to Bethlehem Steel Co., provides a method for controlling the partial blowing of bessemer steel to obtain metal of any required carbon content.

The radiant energy emitted by the converter flame during the blow is measured and recorded by means of a photoelectric tube using a suitable frequency band pass filter (0.32 to 0.36 micron). A typical curve is shown in Figure 1, each time division representing approximately one minute. The length of the "carbon plateau" depends on the ratio of the effective area of the tuyeres in use to that of the total number of tuyeres available, as indicated in Figure 2.

Figure 3 shows the carbon values during the carbon plateau. This line can be used to determine the proper time of blowing.

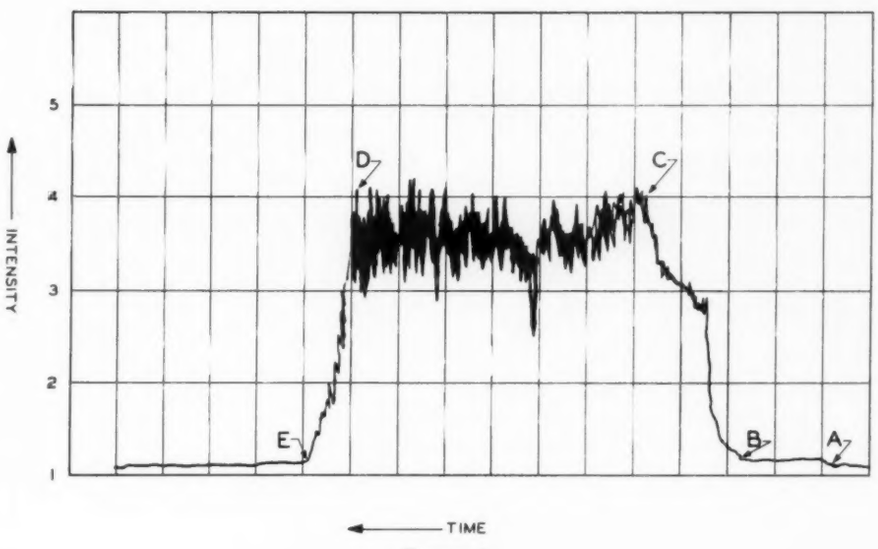


Figure 1

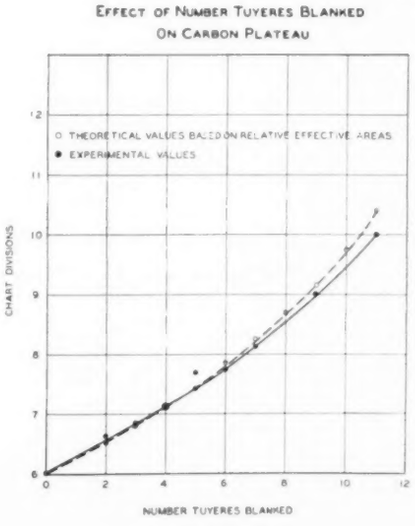

EFFECT OF NUMBER TUYERES BLANKED ON CARBON PLATEAU
O THEORETICAL VALUES BASED ON RELATIVE EFFECTIVE AREAS
● EXPERIMENTAL VALUES
CHART DIVISIONS
NUMBER TUYERES BLANKED

Figure 2

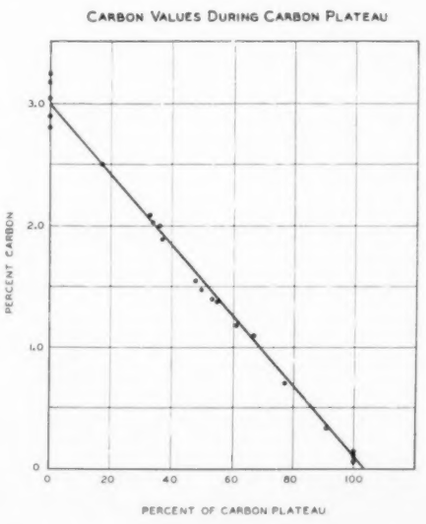


Figure 3

CHARGING ORE

△ U. S. 2,806,775, issued Sept. 17, 1957 to Howard F. West and John H. Veale, assigned to Illinois Clay Products Co., relates to a natural iron oxide brick which is to be used as a charging ore for open hearth and blast furnaces. The brick

has a density such that (a) it will sink through the slag in an open hearth furnace, and (b) it will remain in brick form in a blast furnace until immediately before it is converted into metallic iron.

Hematite fines are mixed with 2 to 10 per cent by weight of 90 to 100 per cent H_2SO_4 and the mixture is pressed together by the usual dry pressing operation used to make fire clay bricks. The composition is heated, forming ferric sulphate bonds. These bonds will be destroyed as the temperature passes 1000 F. They hold the hematite brick in form during the initial heating in the kiln, and then after destruction of these sulphate bonds, because the bricks are in the kiln and not subjected to rough treatment, the bricks retain their form until the ceramic bonds commence to form. These restore the strength of the brick.

TREATMENT OF STEEL MILLS WITH LIGHT METAL

△ U. S. 2,805,932, issued Sept. 10, 1957 to Paul Menzen, relates to the addition of light metals such as aluminum, magnesium, or calcium into molten steel or iron in order to "kill" the melt. The object is to provide good distribution of the light metal, overcoming its normal tendency to float on the steel or iron bath.

The rate of rise of light materials in a heavy medium decreases proportionately with increase of the surface-volume ratio. By using sufficiently small particles it is therefore possible to attain such slow speeds that the time required for the particles to travel from the bottom of the bath to the surface is many times greater than the period of treatment. This can be accomplished by using particles whose size is less than 0.5 mm.

CRE REDUCTION IN CANS

△ U. S. 2,805,146, issued Sept. 3, 1957 to John J. Howard and assigned to John C. Howard relates to the production of ferromanganese from flue dust rich in manganese ore and coke, without using a binder or sintering.

As indicated in Figure 4, dry flue dust is fed into steel cans, the tops of which are then crimped and finally

Other Patents of Interest to The Iron and Steel Engineer

Patent No.	Date	Subject	Inventor or assignee
2,804,663 & 5	9/3/57	Control system for continuous casting	The Babcock & Wilcox Co.
2,804,664	9/3/57	Continuous casting apparatus	Joseph B. Brennan
2,804,790	9/3/57	Method and apparatus for forging	Lefere Forge Machine Co.
2,805,141	9/3/57	Pelletizing iron ore	Regents of University of Minnesota
2,805,143	9/3/57	Heating of steel scrap	Caleb Davies, Jr.
2,805,144	9/3/57	Endothermic reduction of iron oxide	Hydrocarbon Research, Inc.
2,805,145	9/3/57	Exothermic metallurgical composition and method of introducing it into ferrous alloy	Mallinckrodt Chemical Works
2,805,150	9/3/57	Composition for addition to cast iron or steel	Vanadium Corp. of America
2,805,851	9/10/57	Apparatus for cooling the melting zone of cupolas	Ernst Becker et al.
2,805,852	9/10/57	Furnace plates of refractory material	Aktiebolaget Kanthal
2,805,933	9/10/57	Preparation of ferrochromium or ferromanganese	Knapsack-Griesheim Aktiengesellschaft
2,805,938	9/10/57	Separation of metal sulphides	Patrick J. McGauley
2,805,939	9/10/57	Treatment of low-grade iron ores	Chemical Construction Corp.
2,805,942	9/10/57	Rider sheets for use in normalizing furnaces	Crucible Steel Co. of America
2,806,000	9/10/57	Cleaning stainless steel	E. I. du Pont de Nemours & Co.
2,806,267	9/17/57	Centrifugal casting molds for making seamless cast iron pipe	Bochumer Verein Fuer Gusstahlfabrikation A.G.
2,806,445	9/17/57	Tinning apparatus for strip metal	Lawrence Holdings (Overseas) Ltd.
2,806,452	9/17/57	Furnace nose construction	Levi S. Longenecker
2,806,776	9/17/57	Method of strengthening iron ore agglomerates	Illinois Clay Products Co.
2,806,777	9/17/57	Crust-bearing iron oxide agglomerate	Illinois Clay Products Co.
2,806,778	9/17/57	Exothermic manganese addition agent	Union Carbide Corp.
2,806,780	9/17/57	Reduction of iron ore in a batch type revolvable furnace	Combustion Processes Co.
2,806,781	9/17/57	Projection of calcium carbide below the surface of molten iron	Air Reduction Co., Inc.
2,806,782	9/17/57	Method of producing stabilized austenitic cast-steel	Aktiengesellschaft Brown Boverie & Cie
2,807,363	9/24/57	Depolarizing particles of magnetic material	United States Steel Corp.
2,807,372	9/24/57	Door handling gear for use with horizontal coking chamber ovens	Koppers Co., Inc.
2,807,456	9/24/57	Hot metal charging apparatus for open hearth furnaces	Kenneth W. Ott
2,807,506	9/24/57	Oxygen lance nozzle	United States Steel Corp.
2,807,535	9/24/57	Production of sponge iron	Vetrocoke S.p.A.
2,807,536	9/24/57	Reduction of highly siliceous crude iron ore	Ford Motor Co.
2,807,538	9/24/57	Method for removing tin coatings	Atlantic Chemicals & Metals Co.

Figure 4

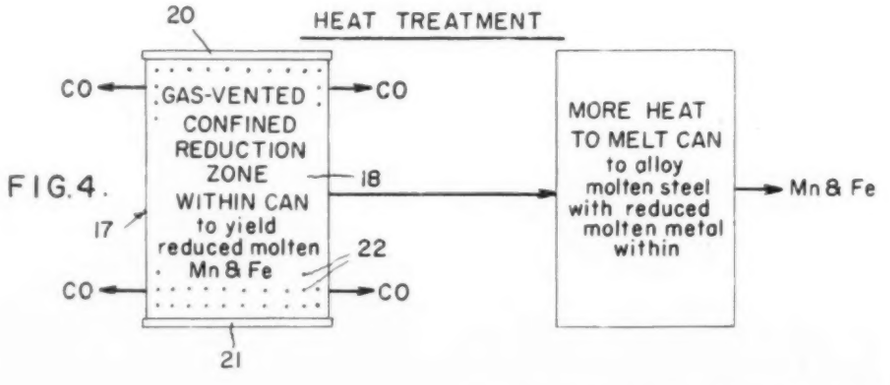
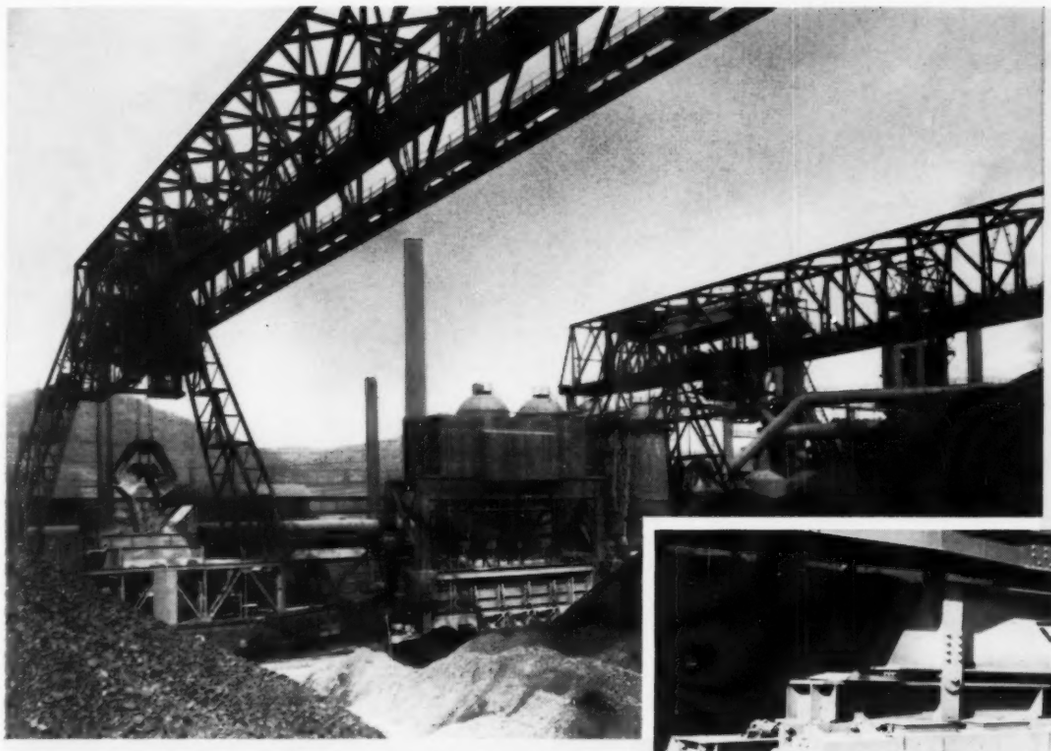
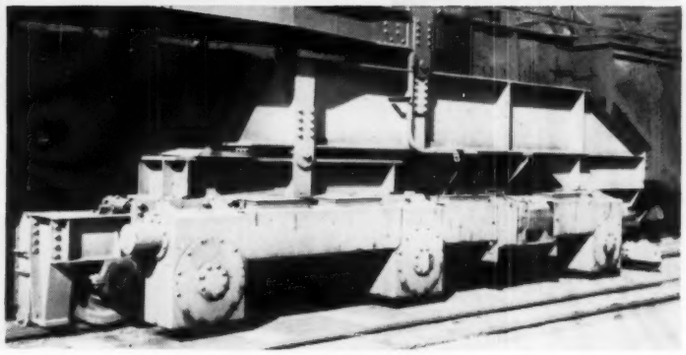


FIG. 4.



Two H & P Man Trolley Ore Bridges and Traveling Turnover Car Dumper serving blast furnace yard.



Fully equalized truck of welded steel construction, flexibly connected to bridge structure.

Ore Handling *all the way* with H&P...

car dumping—stocking—reclaiming

- ORE & COAL BRIDGES
- BOAT LOADERS & UNLOADERS
- COAL & COKE HANDLING EQUIPMENT
- RAILROAD CAR DUMPERS ROTARY, TURNOVER, HIGH-LIFT
- HYDRAULIC RAIL CLAMPS & BUFFERS
- PIG CASTING MACHINES
- SPECIALIZED CONVEYING SYSTEMS
- CAR HAULS & BOAT MOVERS
- COAL PREPARATION PLANTS
- BRADFORD BREAKERS
- THERMAL DRYERS
- WET CYCLONES

For efficient, low-cost operation a prominent Eastern Steel Maker uses a Heyl & Patterson Traveling Turnover Car Dumper and two Heyl & Patterson Ore Bridges to handle raw materials out of railroad cars into storage piles and then into blast furnace transfer cars for delivery to furnace bins.

Both bridges are equipped with Hopper and Gates located in the Pier Leg. The two 7' Gates correspond to the two compartments of the Transfer Car. The reclaiming operation of the bridge continues independently of the position of the transfer car. Automatic Rail Clamps provide protection of the bridges. Buffers at both ends of trolley runway secure trolley against overtravel.

INCREASED ORE STORAGE . . . **These bridges give an extra bonus—Ore Storage Piles 16' higher than previous installation.**

When Experience Counts—Count On Heyl & Patterson!

Heyl & Patterson INC.

55 FORT PITT BLVD., PITTSBURGH 22, PA., COurt 1-0750

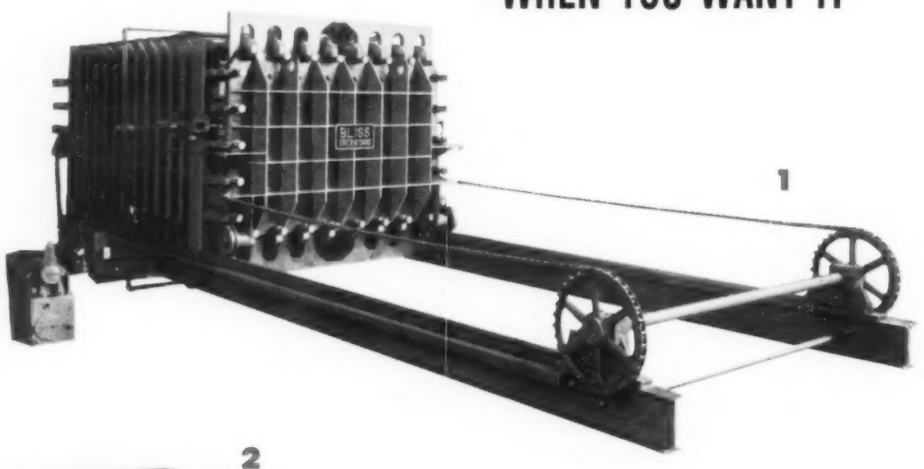
Here are just four examples of the wide range of contract weldments now being fabricated by Bliss. Large and small, ferrous and non ferrous, calling for specialized techniques, jobs like these are an every-day thing to the Bliss personnel in Contract Manufacturing.

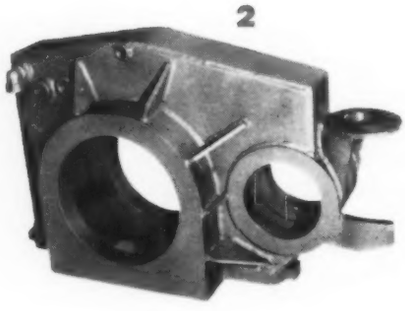
Their experience, combined with heavy machining, welding, metallurgical treatment and inspection facilities, make Bliss a reliable source of welded fabrications. If weldments are your problem, drop us a line... we'll be glad to discuss it with you.

WELDMENTS BY BLISS

...WHAT YOU WANT WHEN YOU WANT IT

1 FILTER PRESS, used in processing of aluminum ore, requires extensive amount of welding. **2 GEAR CASE FOR SUBWAY CAR DRIVE UNITS** is made of welded, pre-machined steel plate; it weighs less than original casting and lowered machining costs. **3 LIGHTWEIGHT ALUMINUM CHIP BUGGY,** welded by Bliss to customer design, reduces handling fatigue considerably. **4 WELDED ALUMINUM STAIRWAY** for factory is rugged, light, attractive, requires no maintenance.





BLISS SINCE 1857 ®

100 years of making metal work for mankind

E. W. BLISS COMPANY

With major weldment facilities at two plants: Salem and Canton, Ohio

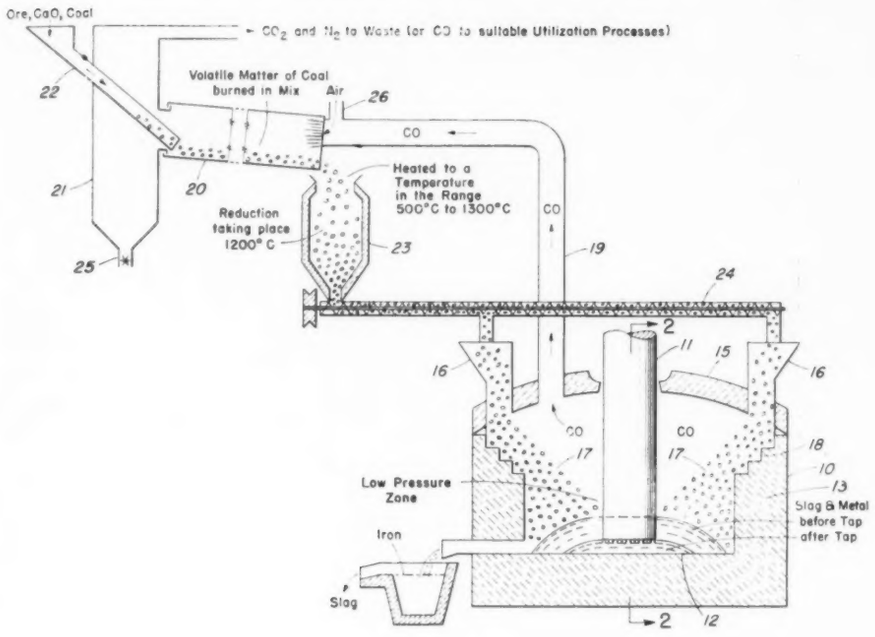

Ore, CaO, Coal
CO_2 and N_2 to Waste (or CO to suitable Utilization Processes)
Volatile Matter of Coal burned in Mix
Air
CO
Heated to a Temperature in the Range 500°C to 1300°C
Reduction taking place 1200° C
Low Pressure Zone
Iron
Slag
Slag & Metal before Tap
after Tap

Figure 5

perforated at a number of points of the cylindrical surface. The cans are not soldered, but are held together by the crimping, in order to avoid adding lead or tin impurities. The cans are placed in a blast furnace or an open hearth furnace, where the temperature of the contents is raised to reaction-inducing temperature. In the can, the oxides of the ore particles are reduced by the particles of coke in the flue dust, yielding a mass of molten metallic manganese and iron, and carbon monoxide gas which is vented through the small perforations in the cans. Further heat from the furnace melts the steel of the can, this steel alloying itself with the contents of the can.

PRODUCTION OF FINELY DIVIDED IRON FROM ORE IN AN ELECTRIC ARC FURNACE

△ U. S. 2,805,929 and 2,805,930, issued Sept. 10, 1957 to Marvin J. Udy and assigned to Strategic-Udy Metallurgical & Chemical Processes Ltd., provides a method of reducing finely divided iron ore in an electric arc furnace.

A charge of finely divided iron ore, coal, and limestone is introduced into the rotary kiln 20 of Figure 5 through the hopper and chute arrangement 22.

When heating of the charge is desired in order to effect the production of a granular free-flowing product in which particles of the components are bonded together and held in intimate contact, heating may be accomplished by the introduction into the kiln of a combustible mixture of air and carbon monoxide produced in the arc electric furnace 10, through the conduit 19. When combustible volatile matter of the coal is to be oxidized to provide additional heat, air is supplied in the amount required for oxidation of the volatile combustible matter in addition to the amount required for oxidation of the carbon monoxide.

Reduction of iron oxide initiated in the rotary kiln will continue during the period of retention in the storage hopper 23 at temperatures as high as 1200 C.

Charge material discharged from the rotary kiln 20 into the storage hopper 23 is conducted at a controlled rate by means of the screw conveyor 24 to the charging hoppers 16 from where it flows under the influence of gravity into the arc electric furnace and onto the surface of the molten slag bath.

In the operation of the arc electric furnace 10, reduction of iron of the iron oxide of the charge material 17 placed on the surface of the molten slag bath is effected substantially entirely by heat contained in the molten slag bath and delivered by means of arc-developed heat and resistance developed heat resulting from resistance to the flow of electric current passing between electrodes.

PRODUCTION OF IRON FROM CONGLOMERATES

△ U. S. 2,806,779, issued Sept. 17, 1957 to Samuel L. Case and assigned to McWane Cast Iron Pipe Co., provides a method of producing iron from finely divided iron ore and coal, by forming self-sufficient conglomerates, then igniting these conglomerates on a bed under a forced draft of air and causing them to undergo destructive distillation of the coal, thus converting the conglomerate into coherently char-bonded pellets in which part of the iron oxide has been reduced to the metallic state. The coherent pellets are then heated in a smelting furnace to complete the reduction in the presence of carbon remaining from the initial charge.

DIRECT PRODUCTION OF REFINED IRON

△ U. S. 2,805,142, issued Sept. 3, 1957 to Vincenzo S. Arata and assigned to James E. Brassert, describes a process for the production of pure iron and iron-carbon alloys directly from ore and coal, without the production and handling of intermediate materials such as coke and pig iron.

The inventor says that such direct processes cannot be made fully continuous, because this is inconsistent with regular analysis and reliable quality of steel produced. Therefore he uses two or more batch electric furnaces which operate together in a semi-continuous manner.

Figures 6 and 7 show a pair of rotary kilns, 2 and 2′, operating in parallel with each other and in series with a pair of electric furnaces, 10 and 10′. Horizontal screw conveyors 1 and 1′ charge the material continuously into chutes and from these chutes through passageways into kilns 2 and 2′. Such passageways should always be kept full of charge material so as to maintain a seal preventing the escape of the gases which pass through the kilns. After partial reduction and preheating in the kilns 2 and 2′ are complete, the materials pass into a common hopper 4 which has two exits, 5 and 6, each with its own valve. The chute passing out of exit 5 in turn diverges into two chutes, 7 and 8, also provided with individual valves, and through these chutes the materials fall into furnace 10. The passage of materials

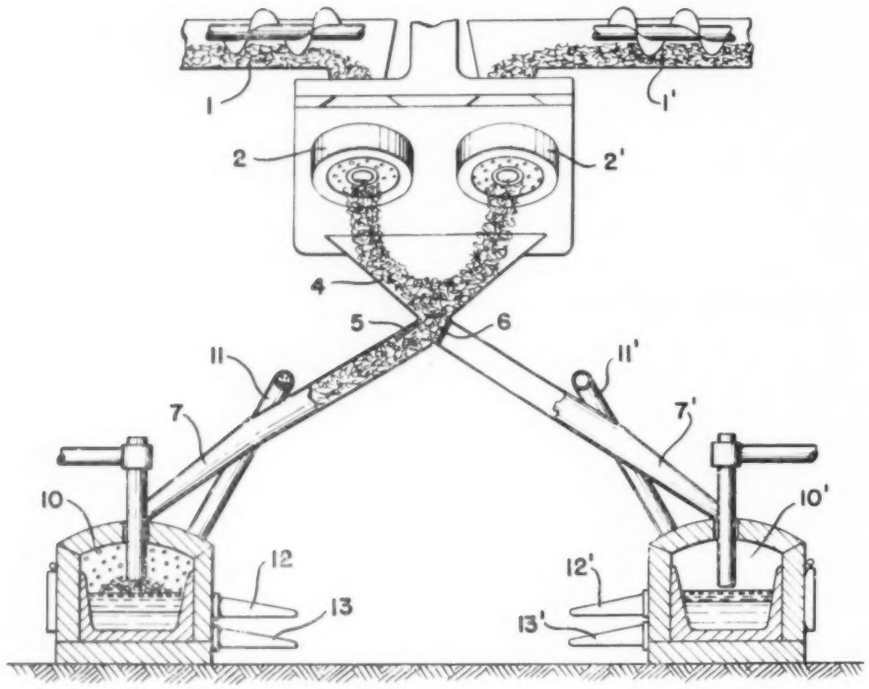


Figure 6

through exit 6 into furnace 10′ is analogous, through chutes 7′ and 8′.

With respect to the flow of gas, uptakes 11, provided with appropriate valves convey the gas evolving from reduction taking place within furnace 10 into collector main 9. Uptakes 11′ similarly connect furnace 10′ to collector main 9 which is common to both of the furnaces. The furnaces are operated in cycle so as to maintain as nearly as possible a steady flow of gas for use elsewhere in the plant.

The patent describes the process cycles in considerable detail.

ROTABLE DRUM FOR REFINING METALS

△ U. S. 2,806,687, issued Sept. 17, 1957 to Rudolf F. Graef, assigned to Huttenwerk Oberhausen A. G., relates to rotary drums for the refining of metals, using an oxygen or air blast.

The novel feature is that the degree of mixing can be varied by a lifting and lowering motion of one end of the drum, independently of rotary movement of the drum. The amplitude and frequency of this lifting and lowering motion is also variable.

MOLD DRYING SYSTEM

△ U. S. 2,804,696, issued Sept. 3, 1957 to Joseph M. Beyvl and assigned to The Foundry Equipment Co., provides a drying system for drying a number of molds for ingot molds.

The discharge of a portion of the air return is arranged so as to be controlled in a manner ensuring uniform treatment of each ingot mold in the system. The molds form parts of a closed system, so that no heated gases which are still at a relatively high temperature and unsaturated are released to the atmosphere.

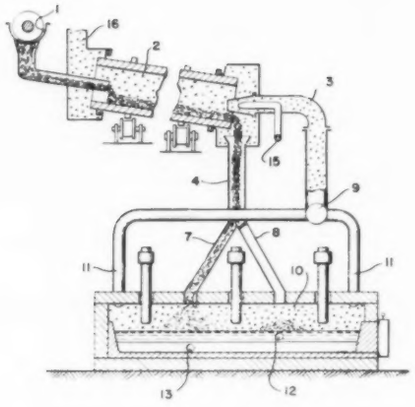


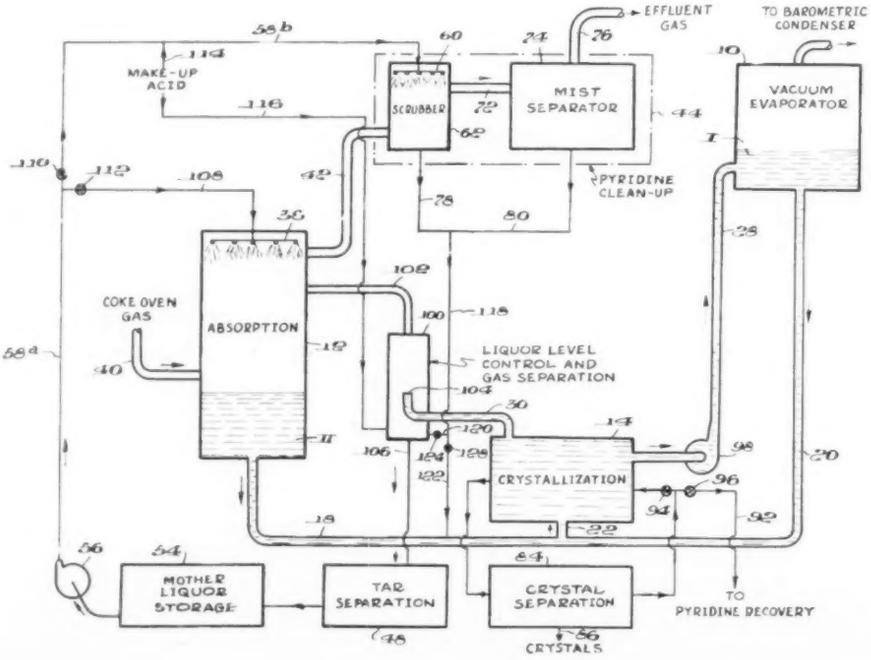
Figure 7

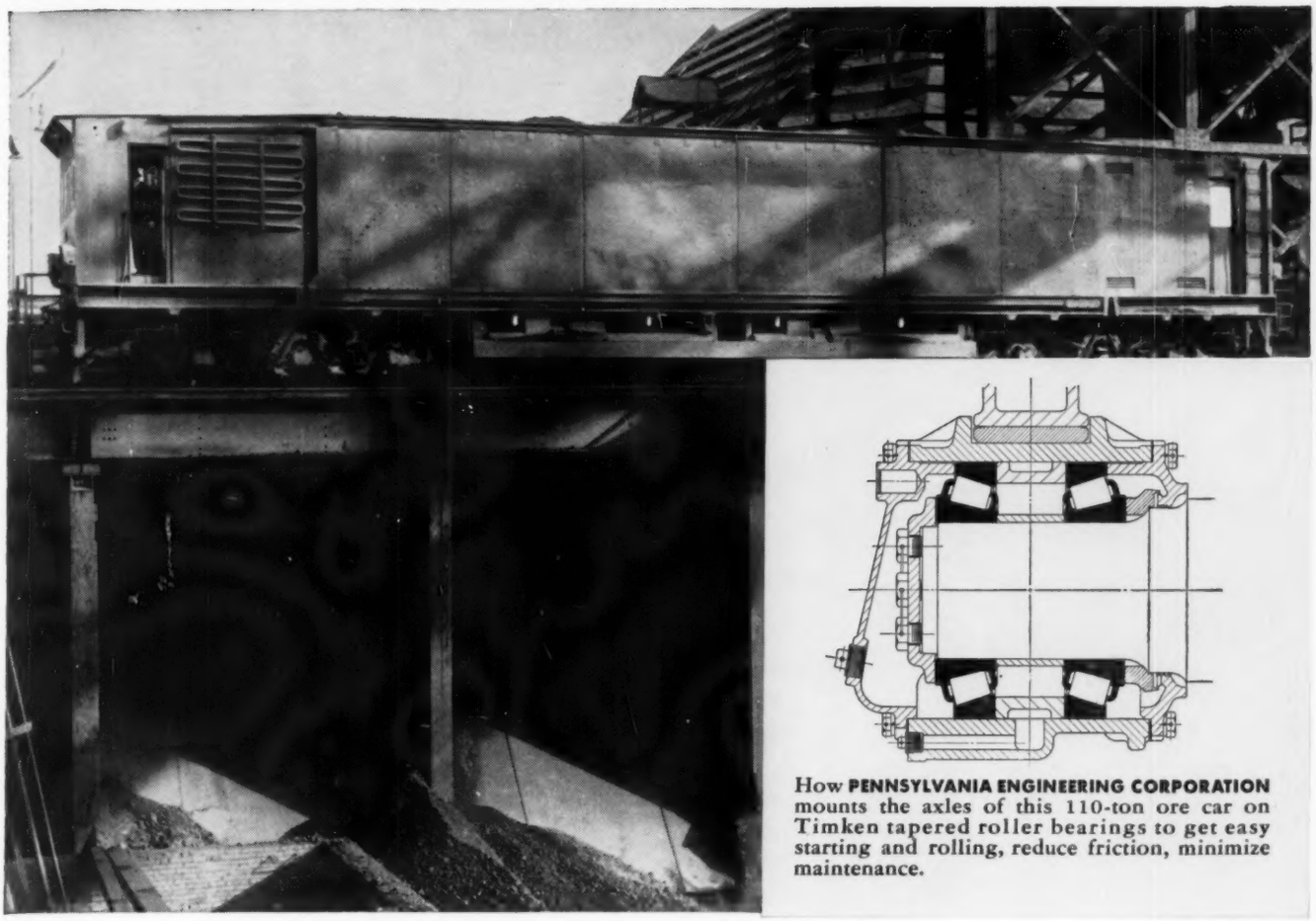
MANUFACTURE OF AMMONIUM SULPHATE FROM COKE OVEN GAS

△ U. S. 2,805,125, issued Sept. 3, 1957 to Joseph van Ackeren, assigned to Koppers Co., Inc., describes a process for the absorption of ammonia from coke oven gas in a dilute sulphuric acid solution, and the subsequent crystallization of ammonium sulphate.

In Figure 8 are shown a vacuum evaporator 10 and an absorber 12, with balanced hydrostatic columns I and II, with a double cycle consisting of an absorption cycle and a supersaturation cycle, the crystallizer 14 being common to both cycles.

Figure 8





How **PENNSYLVANIA ENGINEERING CORPORATION** mounts the axles of this 110-ton ore car on Timken tapered roller bearings to get easy starting and rolling, reduce friction, minimize maintenance.

New 110-ton ore car starts easier, rolls smoother and longer on Timken® bearings

BECAUSE this ore car carries a whopping 110-ton load, it has to be easy to start and keep rolling. It's a natural spot for Timken® tapered roller bearings. And it's no wonder that Pennsylvania Engineering Corporation used them on all 6 axles.

Because Timken bearings *roll* the load, starting resistance is cut up to 88%. There's no metal-to-metal sliding friction. Fully loaded cars start easier, with less power loss.

Geometrically designed and precision-made to roll true, Timken bearings virtually eliminate friction. Cars roll smoothly.

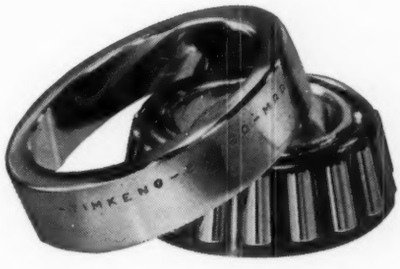
And Timken bearings take the tremendous weight and heavy shock loads. Their rollers and races are case-carburized to have hard, wear-resistant surfaces over tough, shock-resistant cores. Full line contact between rollers and races gives Timken bearings *extra* load-carrying capacity. Their taper lets Timken bearings take both radial and thrust loads in any combination. No costly extra thrust devices are needed. Bearing life is longer, maintenance is minimized.

What's more, by holding housings and shafts concentric, Timken bearings make closures more effective. Dirt and dust stay out. Lubricant stays in.

For all these advantages, specify bearings trade-marked "Timken" for the machines you buy or build. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

TIMKEN BEARING EQUIPPED

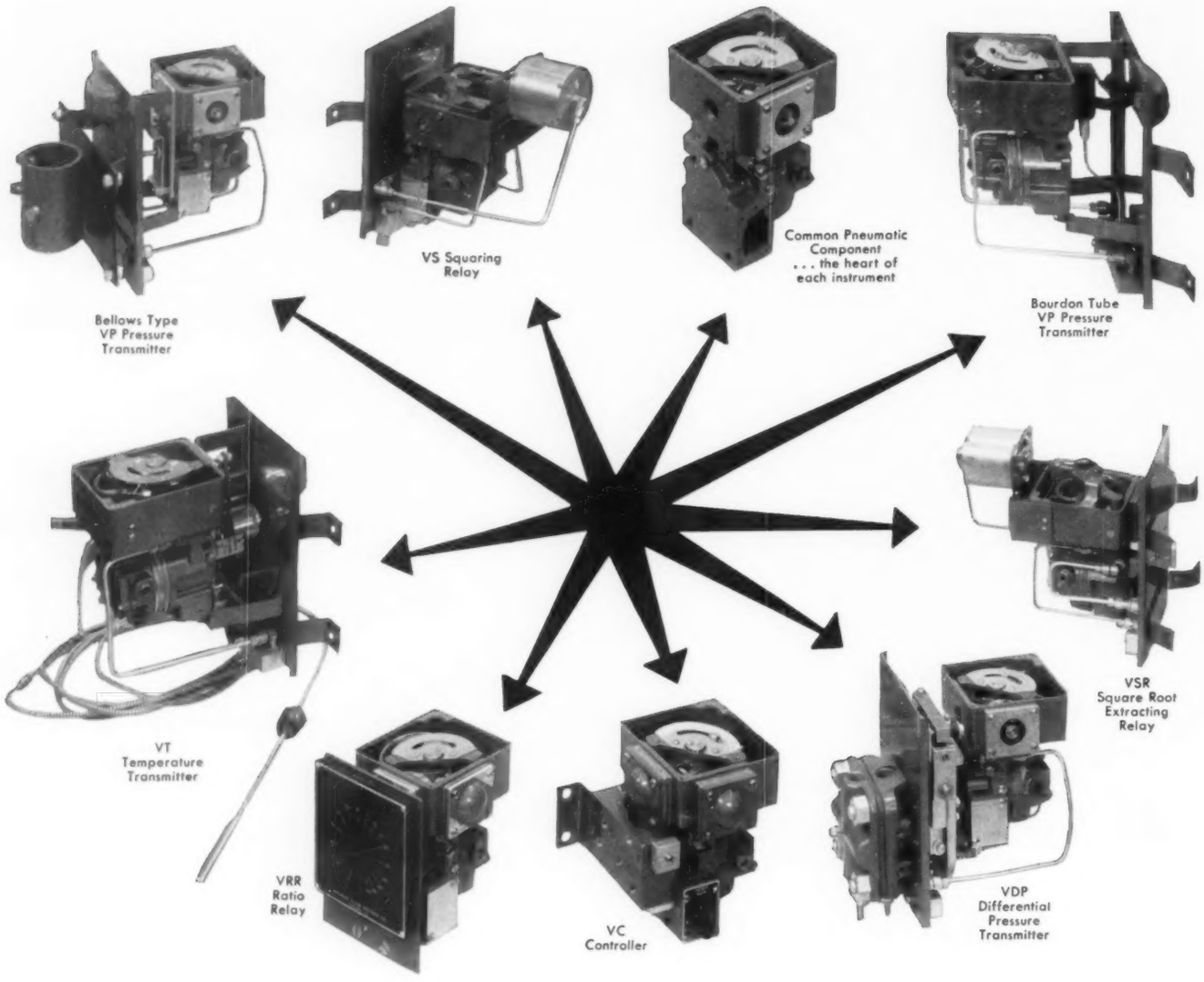
This symbol on a product means its bearings are the best.



TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS ROLL THE LOAD



It's YOUR move—in ANY direction—with

Republic's New Family of Null-Balance-Vector Instruments

Here are only a few of Republic's new line of pneumatic instruments. Their sensitive, extremely accurate components are both compact and interchangeable. Their versatility is phenomenal. Consider: the Vector Series components in *each* of these instruments can be moved and *re-combined in infinite variety*. They form temperature transmitters with 10-to-1 range adjustment . . . pressure transmitters of ±0.5% accuracy . . . differential pressure transmitters with 20-to-1 range adjustment . . . controllers which feature repeatable re-set rate, less than 0.05% dead band and proportional band adjustment from 2 to 500%.

The span of each instrument can be varied at will; only a screwdriver and a reference are necessary—zero need not be re-set. Republic's Null-Balance-Vector design permits full-range operation with virtually no parts motion—and virtually no wear.

This new family of pneumatic instruments was developed in a co-ordinated program to use the greatest possible number of common components. Because these can be interchanged, even among instruments performing entirely different functions, training and spare parts problems are greatly simplified. The versatility of Republic components is at once a challenge and an answer to imaginative engineers. A few minutes of discussion on this subject could be well worthwhile . . . and a call to your nearest Republic Sales Office will set it up at your convenience.

For detailed, descriptive folios write

REPUBLIC FLOW METERS CO.

Subsidiary of ROCKWELL MANUFACTURING COMPANY
2240 DIVERSEY PARKWAY CHICAGO 47, ILLINOIS
In Canada: Republic Flow Meters Canada, Ltd.—Toronto
Manufacturers of electronic and pneumatic instrument and control systems for utility, process and industrial applications.

*Magnified (10 times) surface of steel sheet descaled with Wheelabrator Steel Shot

Over 100 installations have proved that the Wheelabrator mechanical descaling process is cheaper, more efficient, and provides a clean material that produces an improved end product.

Wheelabrator descaling uses no acids or pickle liquors. It removes scale by means of a metallic abrasive blast from one or more rotating wheels. Each wheel hurls abrasive in a fan-shaped pattern against the surface of the material being cleaned.

The resultant matte finish produced by this bombardment consists of minute cups on the surface of the cleaned metal. These cups serve to retain lubricants and drawing compounds, facilitating cold drawing and cold forming. This minutely roughened surface also provides a better bonding surface for coatings.

Cost Savings

1. Reduces or Replaces Acid Pickling
2. Reduces Acid, Acid Disposal
3. Generally Reduces Manhour Needs
4. Reduces Virgin Metal Loss
5. Requires Less Floor Space Than Pickling
6. Reduces Need for Scale Breaking
7. Lowers Cleaning Costs

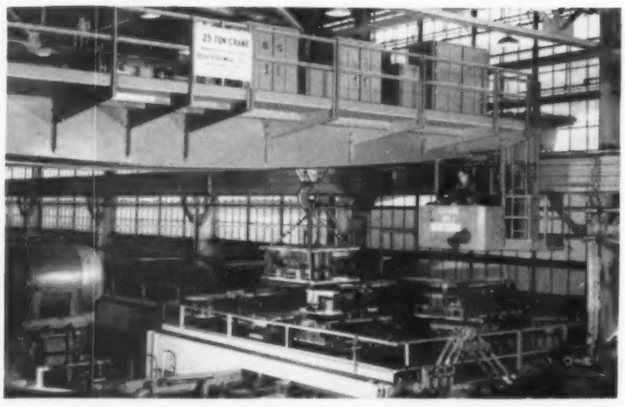
Improved Workability

1. Better Finishes for Cold Rolling
2. Excellent Surface for Cold Drawing
3. Better Surface for Deep Drawing
4. Improved Surface for Cold Forming
5. Better Adherence of Finishes

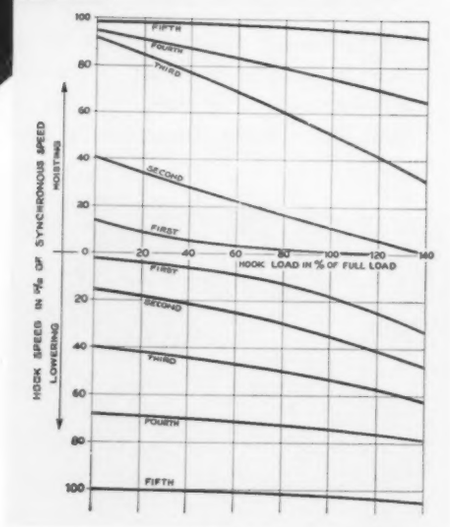
Write today for this informative booklet on Wheelabrator applications in the mechanical cleaning of steel.

WHEELABRATOR
CORPORATION
396 S. Byrkit St. Mishawaka, Indiana

Here's Why Men in Command Specify



25-ton crane, equipped throughout with EC&M Control, gives excellent results in handling dies in automotive plant



Hook-speed curves tell the story! Nearly flat curves, regardless of load. Braking torque regulated from the simplest of magnetic amplifiers. No costly electronic tubes or complicated bias control involved

THE ELECTRIC CONTROLLER & MFG. CO.
A DIVISION OF THE SQUARE D COMPANY
CLEVELAND 28 • OHIO

EC&M EDDYMAG* A-C Crane Control

EC&M PERFORMANCE-PROVEN EQUIPMENT FOR CRANES

ALL LOWERING SPEEDS SAFE because braking torque is automatically adjusted. Any tendency for the motor to speed up increases the eddybrake torque to insure safe lowering of all loads.

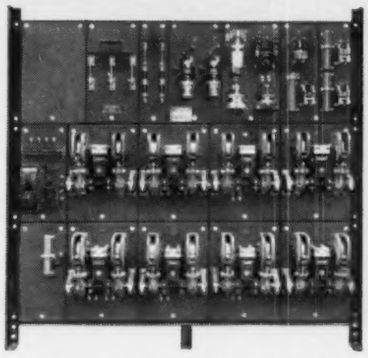
FAST RESPONSE enables the operator to "inch" loads accurately. Speed regulation is excellent, too. On first point, the empty hook starts down and the same point provides slow speed for "inching" heavy loads.

EASIER MAINTENANCE • All EC&M components are standard, mill-type construction—familiar to maintenance men, simple to work with, easy to understand.

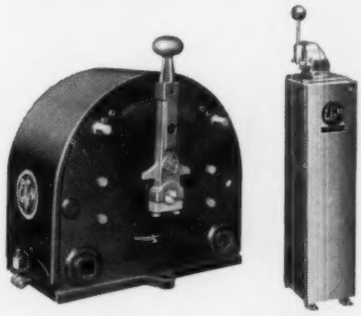
SIMPLE CIRCUITRY • "EDDYMAG" Control uses no sensitive circuits—no tubes to balance. EC&M Frequency Relays, operating from the slip frequency of the motor, provide crane performance unequalled by other methods. Only one plugging relay and one set of acceleration relays required for smooth operation of the a-c wound-rotor motor-driven crane.

Join the men who know performance—specify EC&M Control for your next crane. For complete facts, write for Bulletin 6400

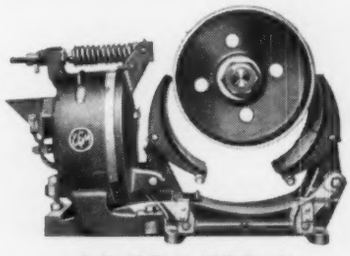
*EDDYMAG is an EC&M registered trademark



EC&M EDDYMAG Hoist Control uses mill-type contactors and relays—off-point braking helps stop the load



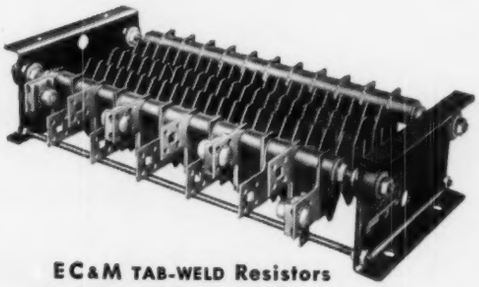
EC&M Master Switches—Cam or Vertical types—are compact, easy to operate



EC&M Type WB Brakes—100% lubricated—dirt can be flushed out

EC&M Manual-Magnetic Disconnect Switches provide a safe and convenient means for "killing" the crane

EC&M Youngstown Safety Limit Stops prevent over-hoisting accidents

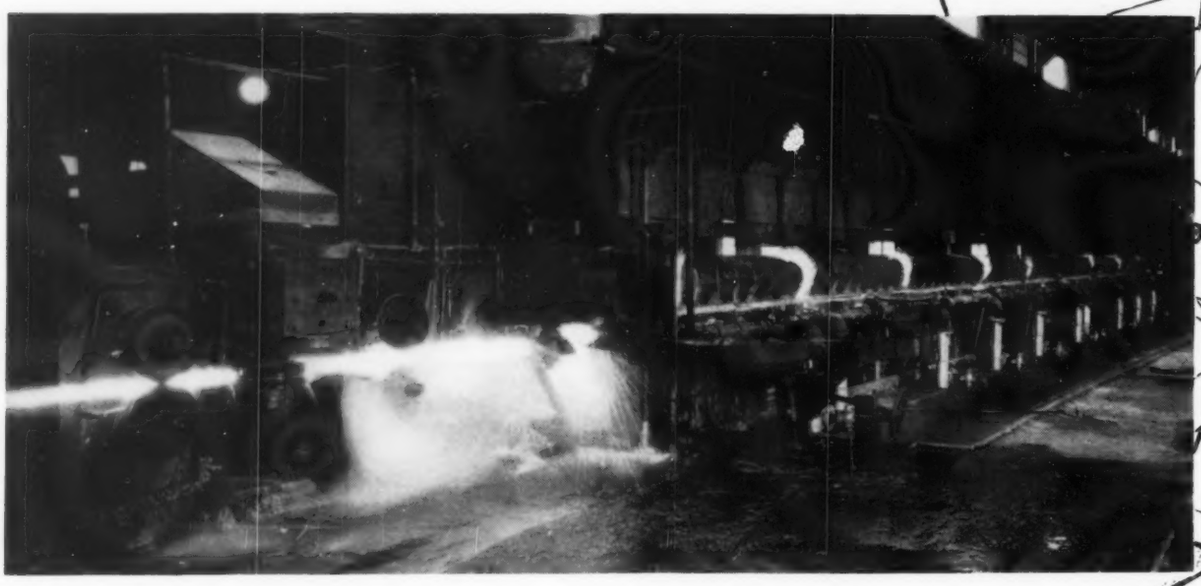


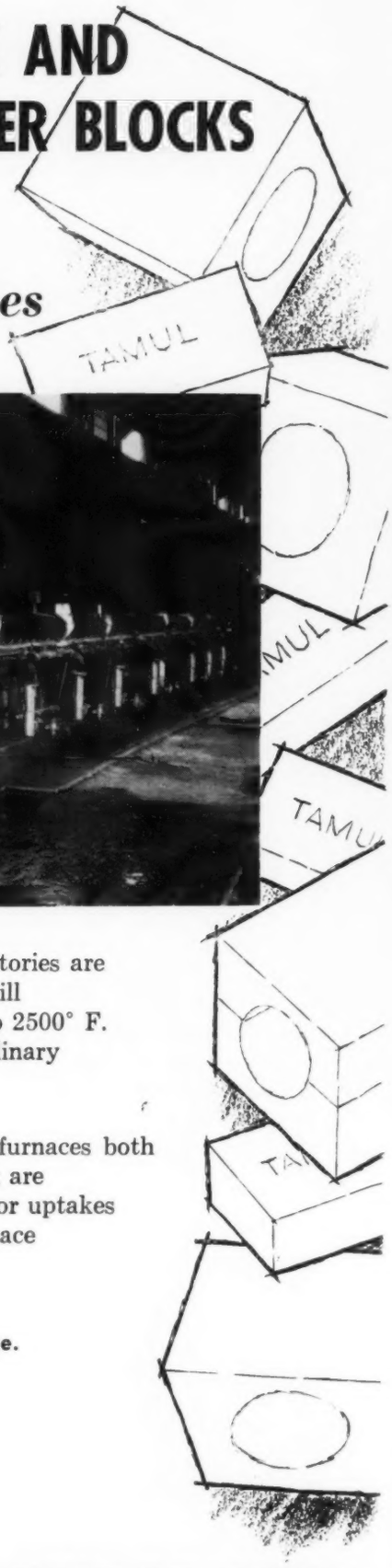
EC&M TAB-WELD Resistors eliminate burning at the grid eyes and at the tap plates

9812

TAMUL BRICK AND BURNER BLOCKS

speed production in continuous pipe mill furnaces





TAMUL® (Taylor sintered synthetic mullite) refractories are preferred by operators of continuous butt-weld pipe mill furnaces*. Heating cold skelp for ½" diameter pipe to 2500° F. in 21 seconds produces furnace conditions in which ordinary refractories quickly fail.

TAMUL burner blocks are regularly used in these furnaces both on original installations and on repairs. TAMUL brick are installed in the inner linings of side walls, in recuperator uptakes and in the bungs. This condition results in longer furnace campaigns because TAMUL has:

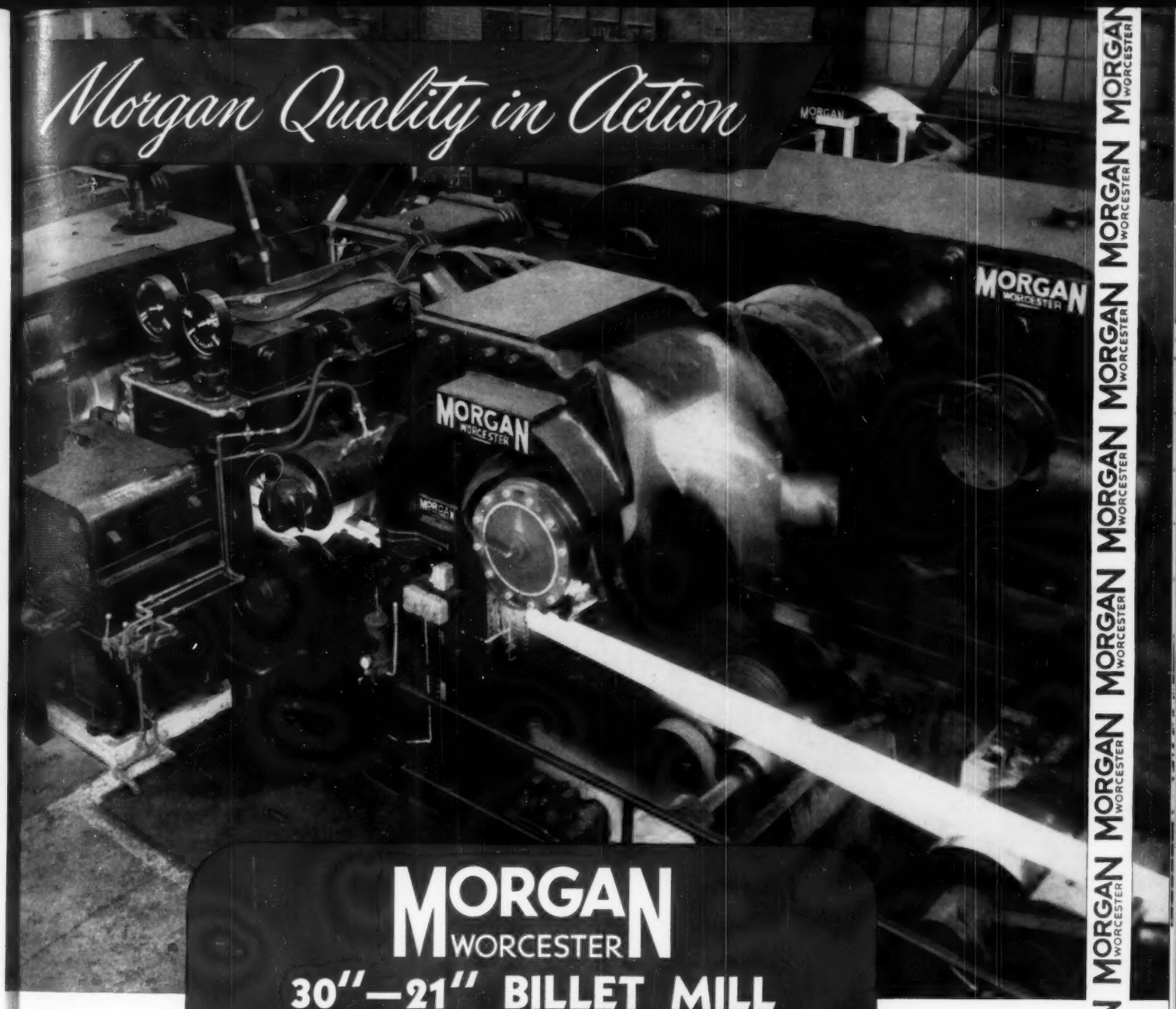
- **High softening point.**
- **Freedom from shrinkage in service.**
- **High hot load strength.**
- **Good resistance to slagging.**

** Engineered and built by Salem-Brosius, Inc., Pittsburgh, Pa.*

Exclusive Agents in Canada:
REFRACTORIES ENGINEERING AND SUPPLIES, LTD.
Hamilton and Montreal

The **CHAS. TAYLOR SONS Co.**
A SUBSIDIARY OF NATIONAL LEAD COMPANY
REG. U. S. PAT. OFF.
REFRACTORIES SINCE 1864 • CINCINNATI • OHIO • U.S.A.

Morgan Quality in Action



MORGAN WORCESTER

30"—21" BILLET MILL

with No.5 Electric Flying Shear in Action

Every Morgan Mill is developed by highly skilled technical engineers to answer the exacting demands of mass production. Morgan introduced the first successful continuous rolling mill in this country—and has consistently maintained leadership in producing quality, high production mills in this country and abroad.

MORGAN CONSTRUCTION CO.

WORCESTER, MASSACHUSETTS

ROLLING MILLS MORGOIL BEARINGS GAS PRODUCERS
WIRE MILLS EJECTORS REGENERATIVE FURNACE CONTROL

RM-46

MORGAN WORCESTER MORGAN WORCESTER MORGAN WORCESTER MORGAN WORCESTER MORGAN WORCESTER MORGAN WORCESTER MORGAN WORCESTER MORGAN WORCESTER

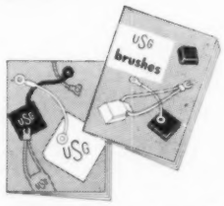
MORGAN WORCESTER MORGAN WORCESTER MORGAN WORCESTER MORGAN WORCESTER MORGAN WORCESTER MORGAN WORCESTER MORGAN WORCESTER MORGAN WORCESTER

THIS USG® BRUSH REDUCES MAINTENANCE ON ALL MILL MOTORS

The brushes in steel mill motors and generators don't cost much, but they can make or break a production schedule. Run up maintenance costs, too. The economical USG Brush Grade 223 can reduce maintenance on motors because of its long-wearing qualities. The proven success of USG Brush Grade 223 is a result of fifty years' experience on all types of mill motors under all conceivable conditions.

But not only does the USG Brush 223 have a longer life . . . it has a permanent shunt connection found on all USG Brushes . . . called STATITE®. The shunt can't be jerked out and will not jar loose.

For low mill motor maintenance and longer brush life with minimum wear, specify the USG Brush Grade 223 with the permanent shunt connection, STATITE.



Copies of the latest USG Brush Catalog B-56 and the new USG Brush Grade Supplement are available on request.

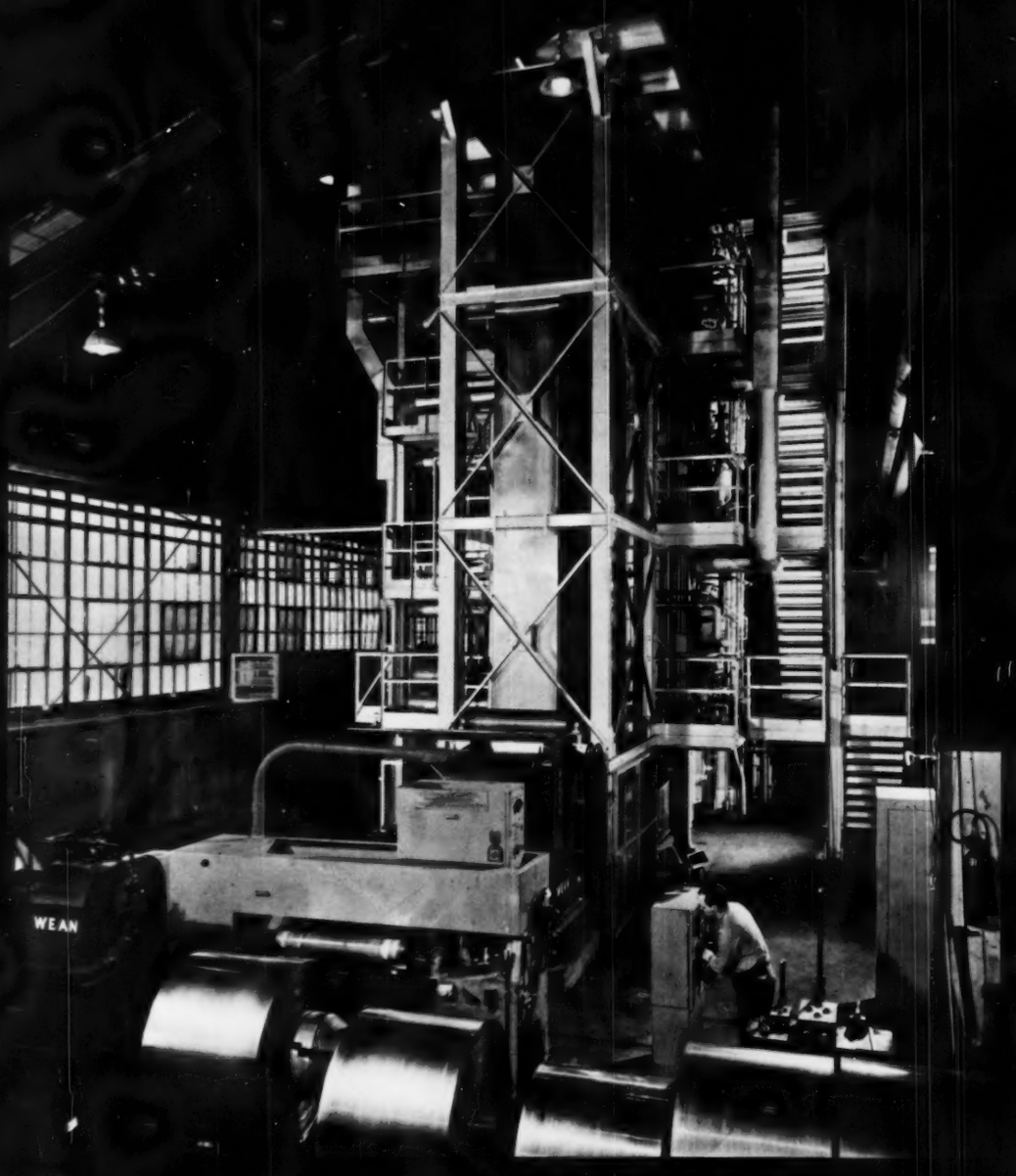
B-254-1

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 9, MICHIGAN

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDERED METAL PARTS • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

Wean, Wheeling and Continuous Annealing



420

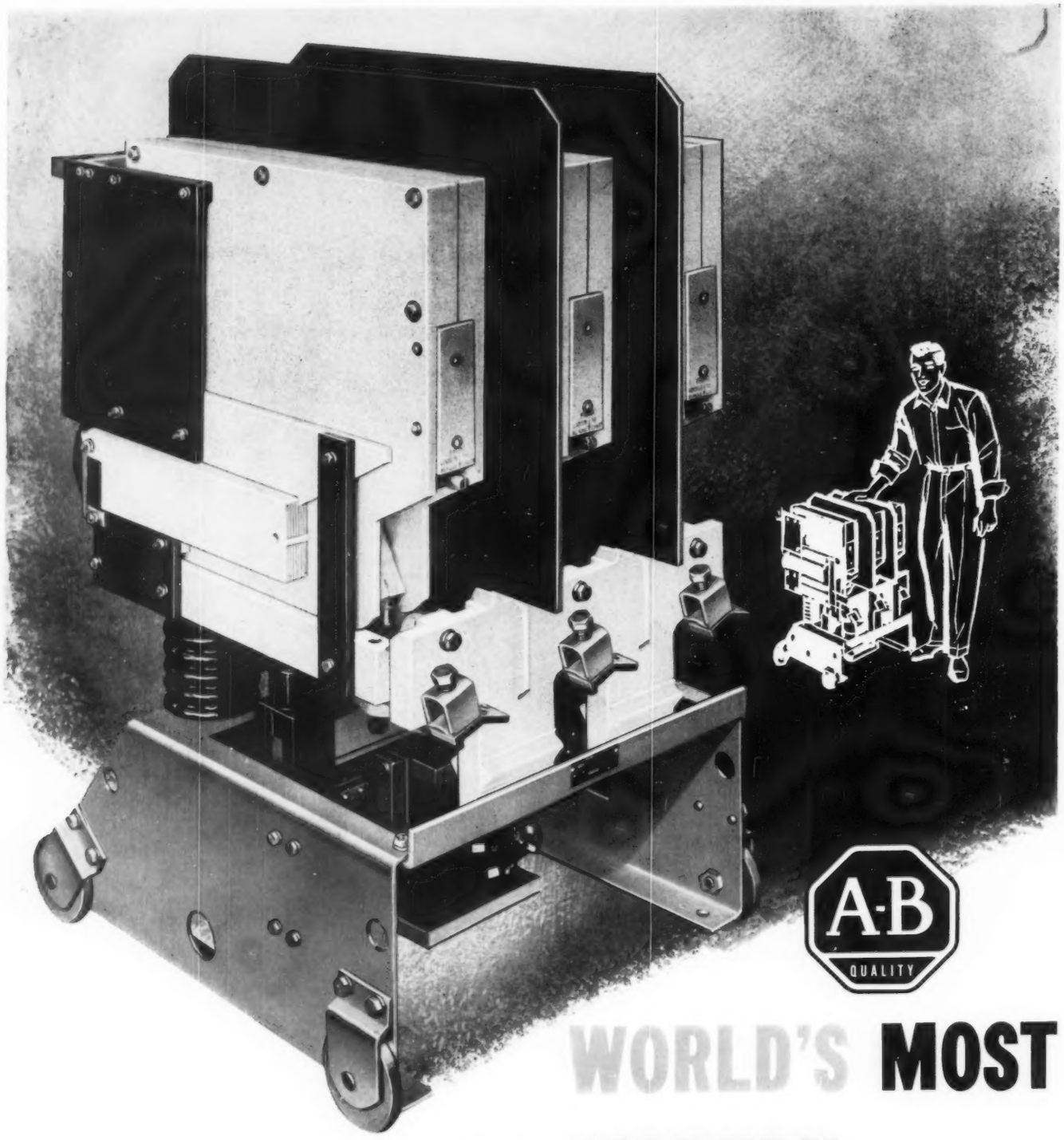
THE continuous strip annealing line above is functional proof of Wean Creative Engineering. Installed in Wheeling Steel's Yorkville (Ohio) plant in 1947, it is still maintaining uniform quality of product at high production rates.

A leading pioneer in the development of the continuous strip annealing process, Wean early realized its outstanding advantages; more uniform anneal . . . better surface uniformity . . . better metallurgical control . . . less cold rolling required for tempering. But perhaps most impressive is the fact that previous methods required thirty-six hours to anneal a 6,000 lb. coil. Today, a Wean Continuous Strip Line anneals the same coil in a matter of minutes.

Nine Wean Continuous Strip Annealing Lines have been built to date. Why not bring this vast experience to bear on your annealing problems.

WEAN

THE WEAN ENGINEERING COMPANY, INC. WARREN, OHIO



WORLD'S MOST MODERN HIGH VOLTAGE SWITCH

Modern in every sense of the word . . . this new air break switch is the *heart* of the Allen-Bradley line of high voltage starters.

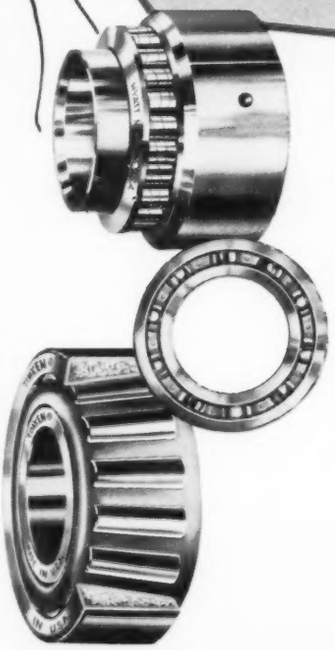
Utilizing the time-tested Allen-Bradley solenoid design—having only *one* moving part—a tremendous operating life is assured. And the double break, silver alloy contacts require no maintenance. Regardless of the frequency of operation, they are always in good operating condition—until the contact is completely worn out.

These new 5000 volt air break switches are available in full voltage and reduced voltage starters—nonreversing and reversing—for squirrel cage, part winding, slip ring, and synchronous motors. Maximum rating: 1500 hp, 2300 volts; 2500 hp, 4600 volts. Please write for Bulletin 6080.

ALLEN-BRADLEY QUALITY MOTOR CONTROL

Allen-Bradley Co., 1343 S. First St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

from 39¢ to $19,092.50



EVERY time you order bearings, bearing specialties, or transmission appliances from Berry Bearing Company--you can be sure of *immediate delivery*--regardless of the size or dollar value of your order.

In fact, Berry Bearing's 37 year old policy of immediate delivery is based on a sincere desire to give ALL customers--both large and small--the finest, fastest service possible. It is not governed by how much a customer spends ...or...how often he orders. That policy has helped make Berry one of the largest bearing distributors in the United States.

So, whether what you order invoices 39¢ or $19,092.50--you'll get speedy service every time. And, with over 50,000 bearings, bearing specialties, and transmission appliances regularly carried in stock you can depend on Berry Bearing Company to have exactly what you want. In addition, you can bank on delivery in approximately 27 minutes.

Don't hesitate to phone in an order right now, for *anything* you need.

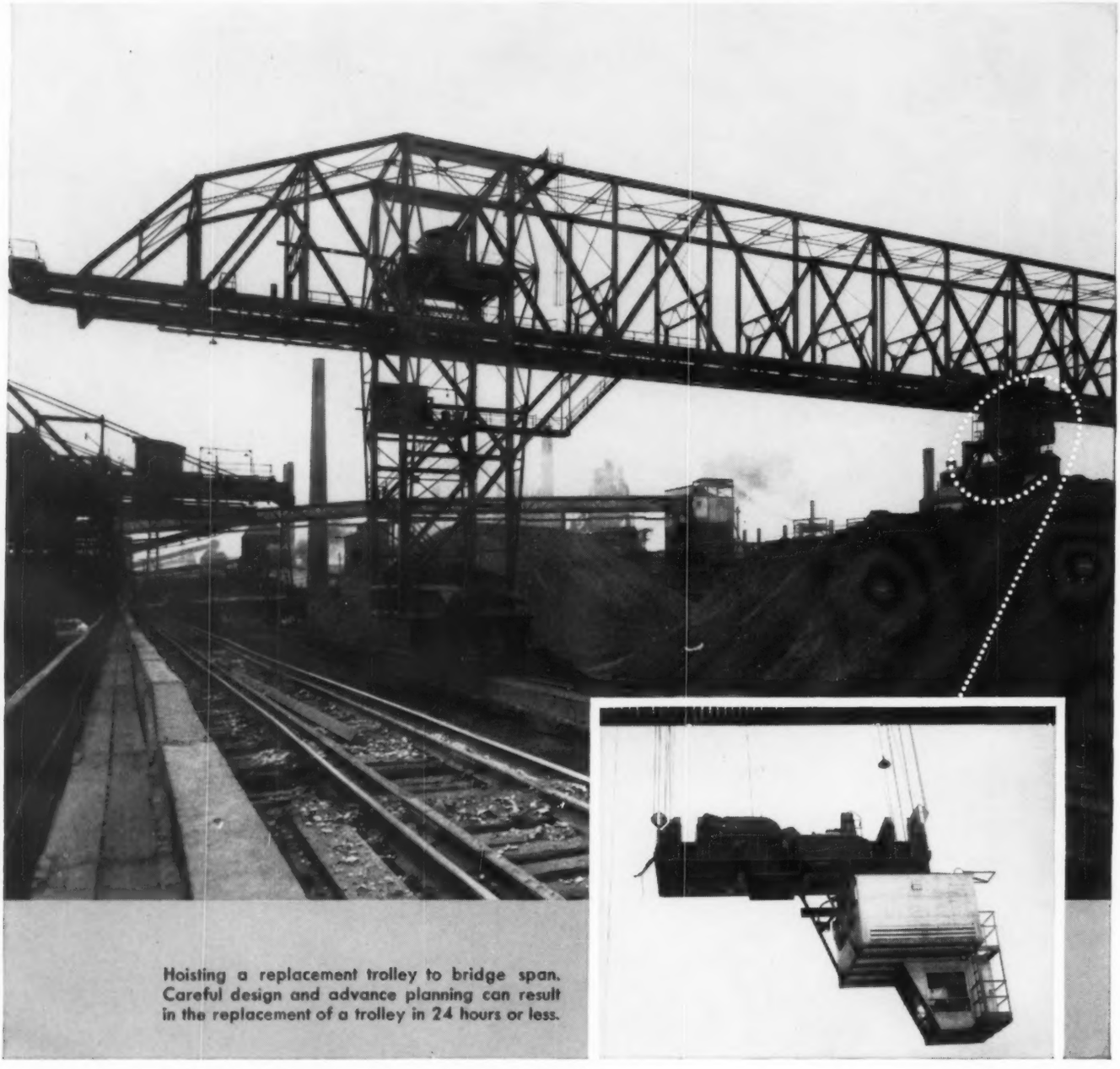
MEMBER AFBDA ANTI-FRICTION BEARING DISTRIBUTORS ASSOCIATION

BERRY BEARING COMPANY

All phones--DAnube 6-6800

2633 S. Michigan Ave. Chicago 16, Illinois

SOUTHWEST	OAK PARK	SKOKIE	ROCKFORD	HAMMOND	GARY
6923 W. Archer Ave.	327 Madison St.	4438 Oakton St.	710 Broadway	4828 Calumet Ave.	716 E. 5th Ave.
LUdlow 5-4400	EUclid 6-1700	ORchard 4-6600	Phone 2-5561	WEstmore 1-3010	TUrner 5-7501



Hoisting a replacement trolley to bridge span. Careful design and advance planning can result in the replacement of a trolley in 24 hours or less.

Eastern steel mill modernizes 4 old bridges with DRAVO REPLACEMENT TROLLEYS

This eastern steel mill has found that old bridges can easily be restored to high productive capacity by replacing old and worn-out trolleys with new and modern Dravo replacement man trolleys.

The new trolleys permit faster operating speeds and will eliminate the excessive downtime for repair which had hindered bridge operations. The useful life of the bridges has been greatly extended, and production increased materially.

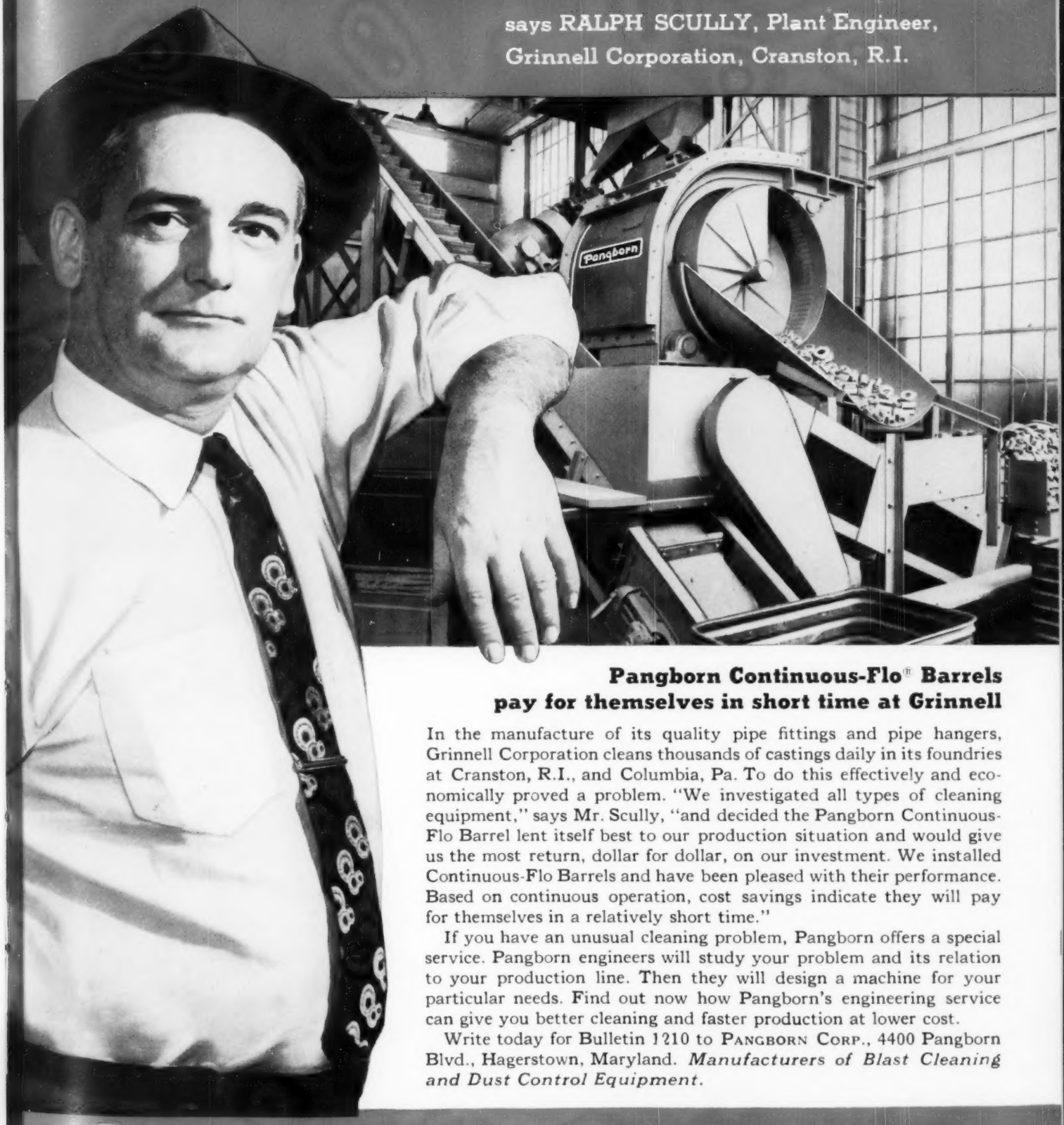
Replacement of inefficient, worn or inadequate trolleys can improve operations at a small fraction of new bridge cost. Consultation with a Dravo engineer may help you eliminate a production bottleneck. For more information, write or phone DRAVO CORPORATION, PITTSBURGH 25, PENNSYLVANIA.

DRAVO
CORPORATION

Blast furnace blowers • boiler and power plants • bridge sub-structures • cab conditioners • docks and unloaders • dredging • fabricated piping foundations • gantry and floating cranes • gas and oil pumping stations • locks and dams • ore and coal bridges • process equipment • pumphouses and intakes • river sand and gravel • sintering plants • slopes, shafts, tunnels • space heaters • steel grating • towboats, barges, river transportation

"...the most return, dollar for dollar, on our investment"

says RALPH SCULLY, Plant Engineer,
Grinnell Corporation, Cranston, R.I.



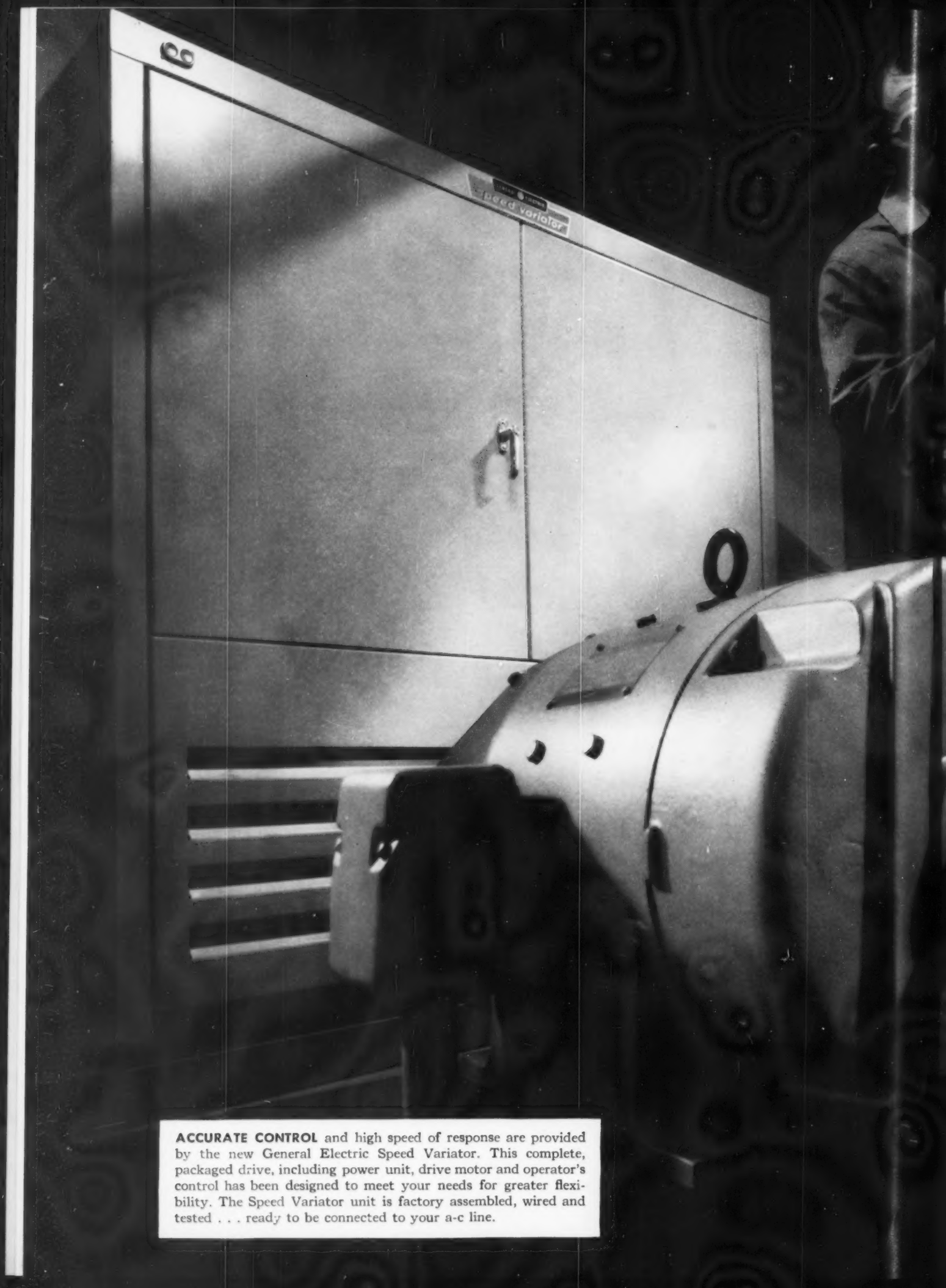
Pangborn Continuous-Flo® Barrels pay for themselves in short time at Grinnell

In the manufacture of its quality pipe fittings and pipe hangers, Grinnell Corporation cleans thousands of castings daily in its foundries at Cranston, R.I., and Columbia, Pa. To do this effectively and economically proved a problem. "We investigated all types of cleaning equipment," says Mr. Scully, "and decided the Pangborn Continuous-Flo Barrel lent itself best to our production situation and would give us the most return, dollar for dollar, on our investment. We installed Continuous-Flo Barrels and have been pleased with their performance. Based on continuous operation, cost savings indicate they will pay for themselves in a relatively short time."

If you have an unusual cleaning problem, Pangborn offers a special service. Pangborn engineers will study your problem and its relation to your production line. Then they will design a machine for your particular needs. Find out now how Pangborn's engineering service can give you better cleaning and faster production at lower cost.

Write today for Bulletin 1210 to PANGBORN CORP., 4400 Pangborn Blvd., Hagerstown, Maryland. *Manufacturers of Blast Cleaning and Dust Control Equipment.*

Pangborn blast cleans cheaper



ACCURATE CONTROL and high speed of response are provided by the new General Electric Speed Variator. This complete, packaged drive, including power unit, drive motor and operator's control has been designed to meet your needs for greater flexibility. The Speed Variator unit is factory assembled, wired and tested . . . ready to be connected to your a-c line.

NEW

General Electric Speed Variator

An Adjustable-speed Drive with . . .

- Amplistat® Regulator
- Static Exciter
- Kinamatic* Drive Motors
- Silicon Rectifiers
- Two-Unit, Four-Bearing Motor-Generator Set

*Trademark of General Electric Company

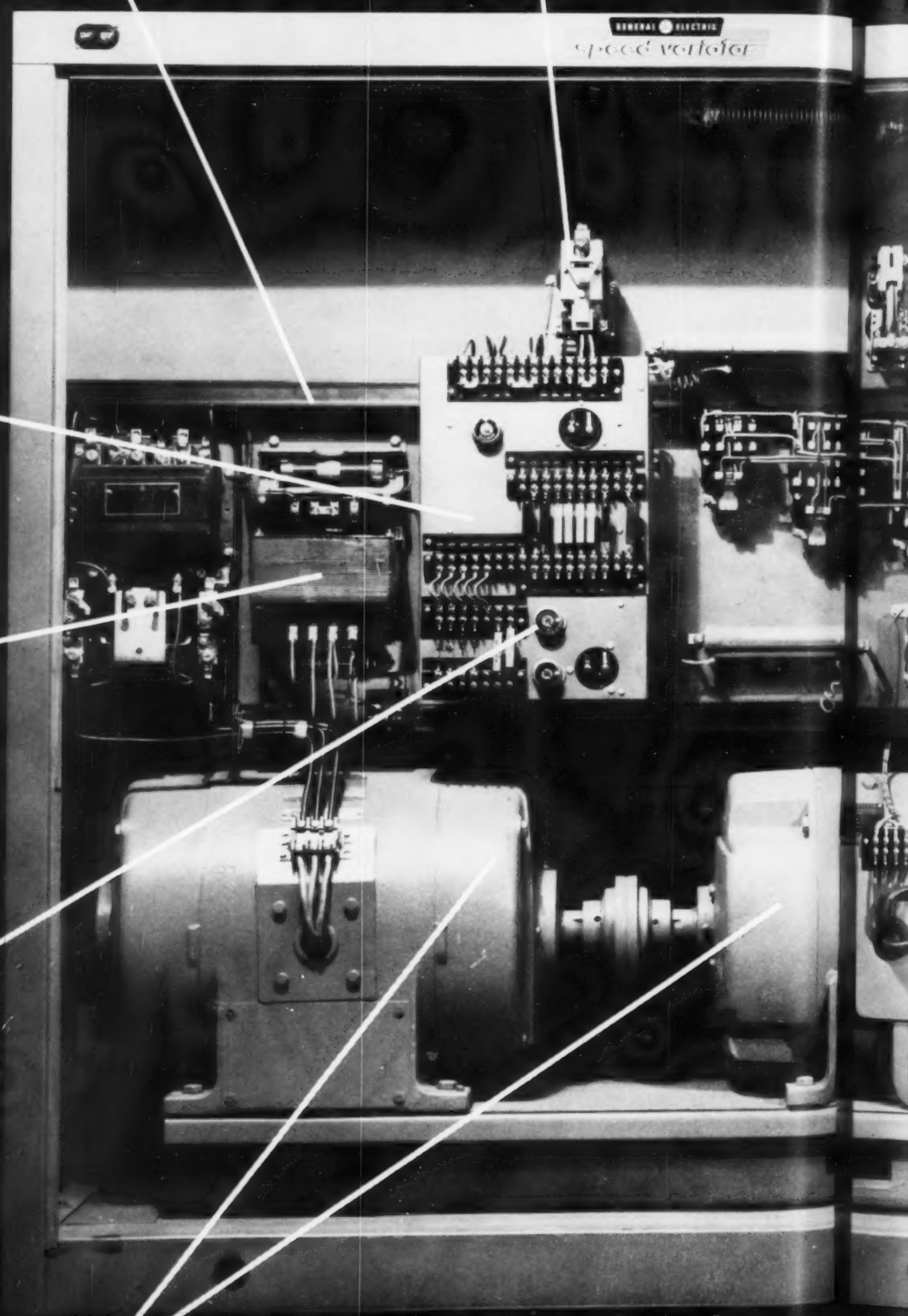
See how the new Speed Variator cuts costs

Progress Is Our Most Important Product

GENERAL ELECTRIC

RECESSED WIRING TROUGHS simplify installation and inspection. Permit back-to-back mounting of control panels when required.

FRONT-CONNECTED CONTROL COMPONENTS make servicing and replacement easy. Standard parts can be replaced from stock.



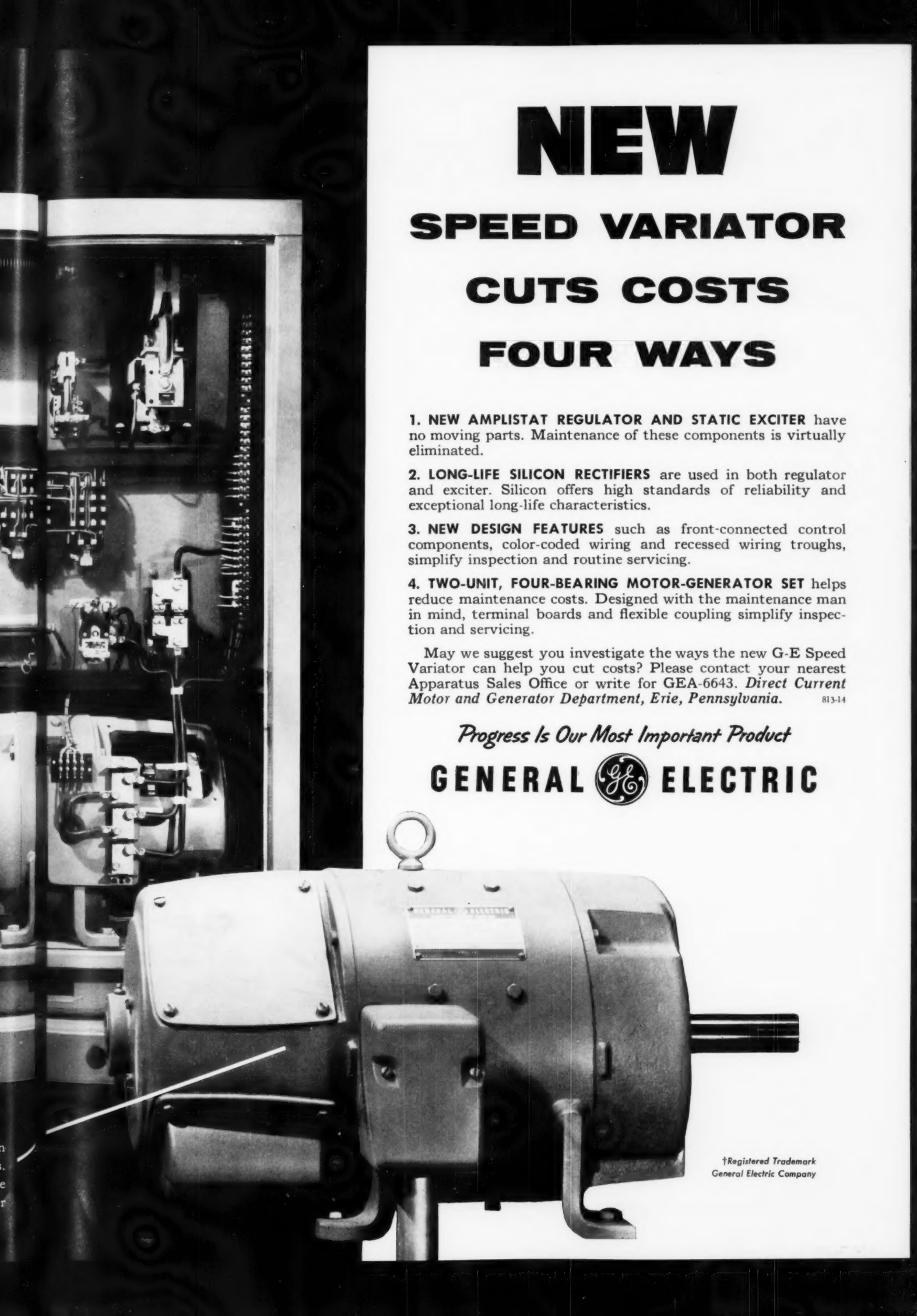
AMPLISTAT REGULATOR is standard equipment on new Speed Variator. It holds speed steady under varying loads . . . has no moving parts.

STATIC EXCITER permits immediate operation because it requires no warm-up time.

TIMED ACCELERATION AND DECELERATION permits smooth, controlled starts by means of simple potentiometer knob adjustment.

TWO-UNIT, FOUR-BEARING MOTOR-GENERATOR SET features latest design Tri-Clad† '55' alternating-current motor and direct-current generator. In ratings 3 through 50 hp, set is mounted on base in which special openings have been provided so that it can be removed by fork truck.

KINAMATIC DRIVE MOTOR can handle greater momentary loads. It provides split-second response to control signals; more power per pound and greater versatility.



NEW

SPEED VARIATOR CUTS COSTS FOUR WAYS

1. NEW AMPLISTAT REGULATOR AND STATIC EXCITER have no moving parts. Maintenance of these components is virtually eliminated.

2. LONG-LIFE SILICON RECTIFIERS are used in both regulator and exciter. Silicon offers high standards of reliability and exceptional long-life characteristics.

3. NEW DESIGN FEATURES such as front-connected control components, color-coded wiring and recessed wiring troughs, simplify inspection and routine servicing.

4. TWO-UNIT, FOUR-BEARING MOTOR-GENERATOR SET helps reduce maintenance costs. Designed with the maintenance man in mind, terminal boards and flexible coupling simplify inspection and servicing.

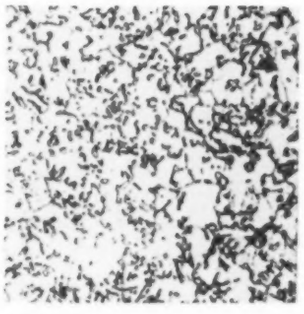
May we suggest you investigate the ways the new G-E Speed Variator can help you cut costs? Please contact your nearest Apparatus Sales Office or write for GEA-6643. *Direct Current Motor and Generator Department, Erie, Pennsylvania.* 813-14

Progress Is Our Most Important Product

GENERAL ELECTRIC

†*Registered Trademark*
General Electric Company

carbon-restored steel meets tightest specs



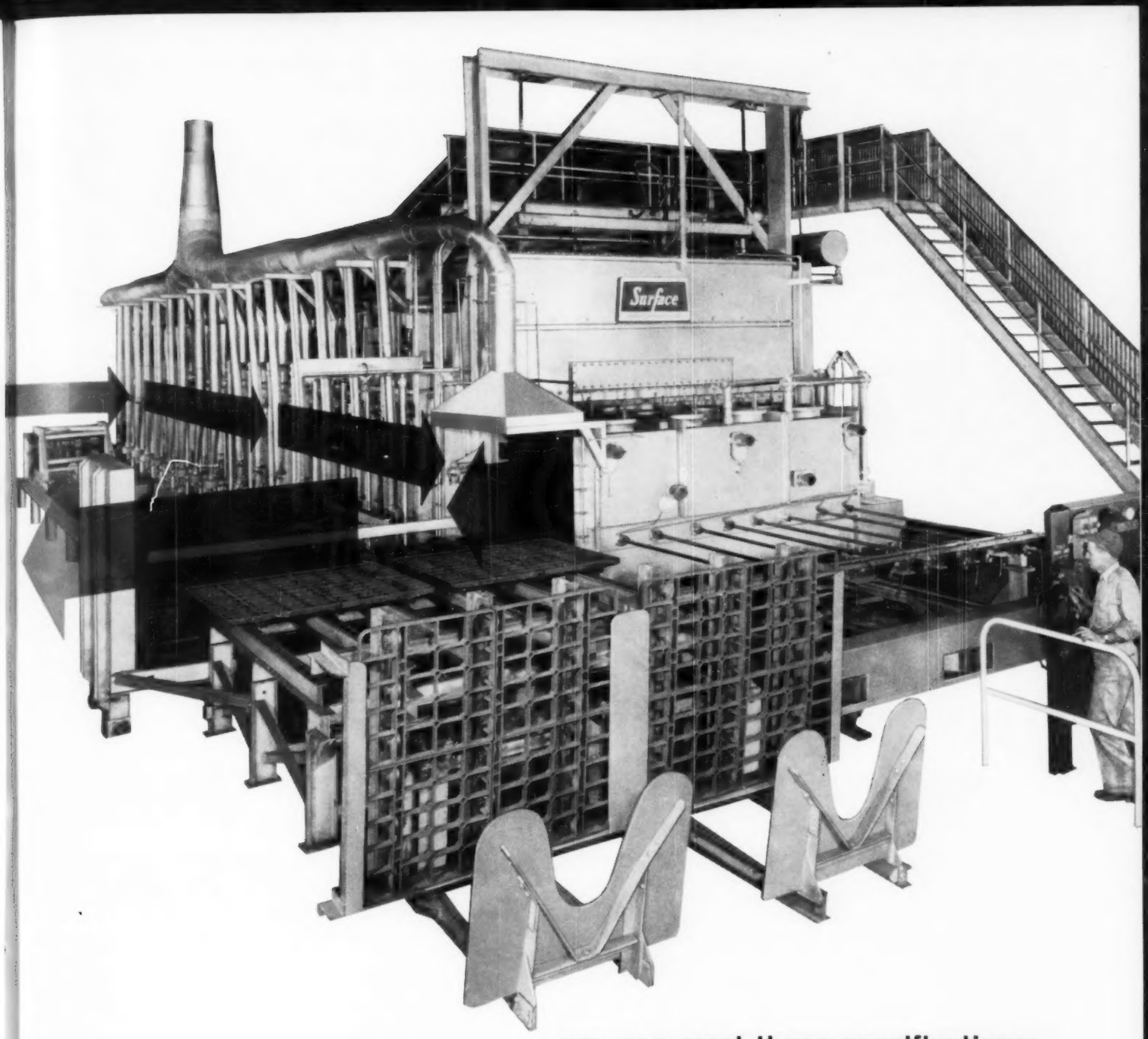
■ This steel mill easily meets the steadily tightened specifications of customers who demand stock with good surface finish, no "decarb," and uniform microstructures suitable for cold forming and automatic machining.

They do it by combining annealing and carbon restoration in a Surface continuous furnace. They get all the flexibility of cycle control they need with 6 zones, individually controlled. An RX® gas generator keeps the carbon potential of the furnace atmosphere in balance with the steels being treated. Automatic dew point recorders provide a continuous check on the atmosphere.

Production rates up to 1,000 tons per month make this furnace a profitable tool.

Again, Surface engineering transforms difficult specifications into profitable opportunities.

Surface Combustion Corporation, 2404 Dorr Street, Toledo 1, Ohio.
In Canada: Surface Industrial Furnaces, Ltd., Toronto, Ontario.



you can meet these specifications:

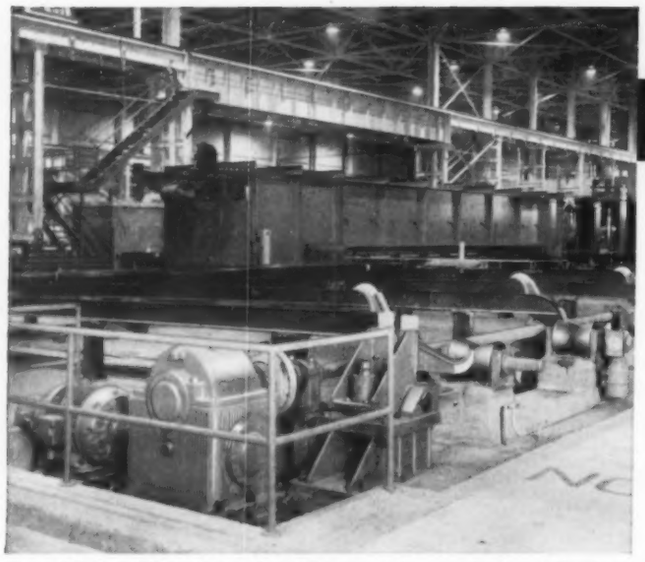
CYCLE ONE (sub-critical anneal)		CYCLE TWO (over-critical anneal)	
STEEL (AISI)	MAXIMUM-BRINELL	STEEL (AISI)	MAXIMUM-BRINELL
4042	160	4037	151
4140	170	4140	174
5140	166	8127	148
8740	170	8740	174

Cycle One production must show spheroidized structure. Cycle Two must show lamellar pearlite structure. Brinell hardness after annealing.

wherever heat is used in industry

Surface®

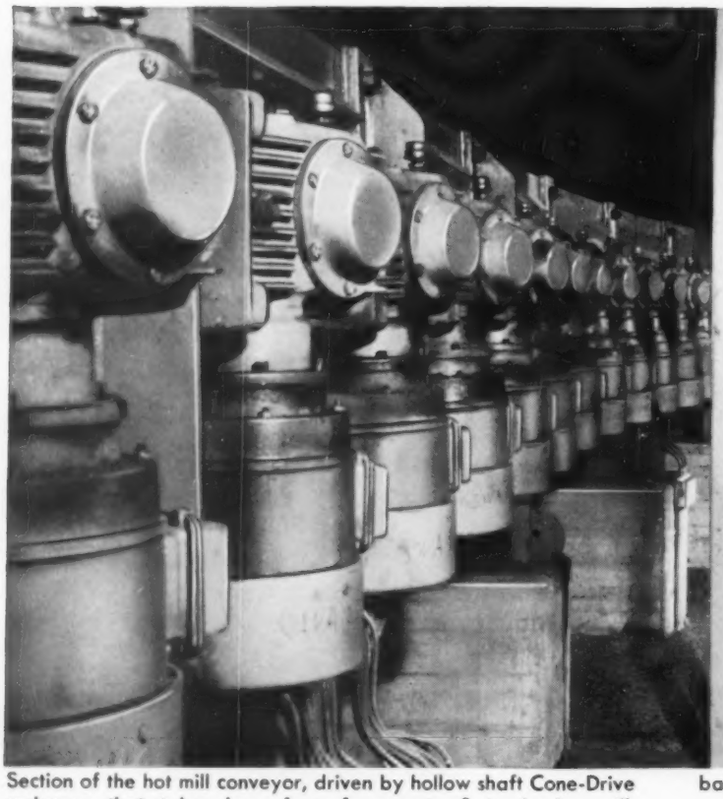
ubaix, Bressoux, Liege • S. A. Forni Stein, Genoa • Chugai Ro Kogyo Kaisha, Ltd., Osaka • Benno Schilde Maschinenbau, A. G., Bad Hersfeld



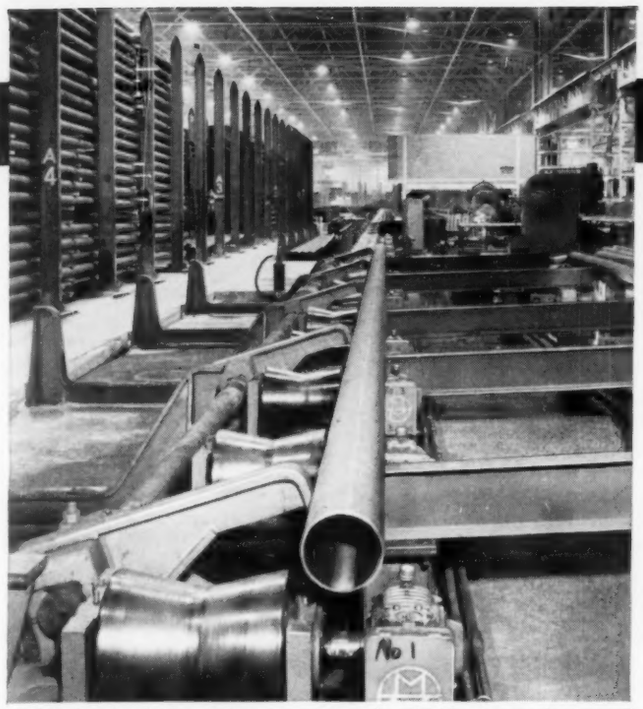
Over 70 Star Wheel transfer drives are the roughest applications in the Mannesmann Tube mill. The Star Wheel shown picks up the heavy tube and transfers it to the transfer skids in one second's time with ⅓ of a revolution of the gearshaft of the Cone-Drive 12-inch center distance worm-under speed reducer. Reducer is driven by a 25-hp high-torque motor.

Plug mill is adjustable to handle diameters from 4½ to 10¾ inch finished OD. Adjustment is made by moving wedges coupled to an Acme threaded shaft driven by a hollow shaft 7-inch center distance Cone-Drive reducer. Power is supplied by 15-hp, 900 rpm high-torque reversing electric motor. Reduction is 40:1. Housing is only one in mill not made of ductile iron.

New MANNESMANN TUBE MILL makes extensive use of double-



Section of the hot mill conveyor, driven by hollow shaft Cone-Drive reducers, that takes bars from furnace to first piercing mill. Conveyor knocks scale from bars while turning corner and raising bars several feet. Hot 3,000 lb. bars travel at a fast rate and service is severe. Motorized reducers have 5:1 reduction. Motor base loosely coupled to stand acts as torque arm.



A 6-inch tube is shown here on a transfer skid between the cut-off machine and the longest conveyor in the Mannesmann mill—the main cold mill conveyor. Each roll on the conveyor, stretching as far as the eye can see, is driven with a motorized hollow shaft Cone-Drive double-enveloping worm gear reducer.

Almost 500 of these standardized individually motorized conveyor units are in use in the Mannesmann mill. Basic components are standard 3-inch center distance Cone-Drive hollow shaft speed reducer and 1½ hp electric motor. This drive is on the conveyor that takes cold bars from the burning machines to the furnace.

e- enveloping worm gear reducers

Mannesmann's new 20-million-dollar tube mill at Sault Ste. Marie, Canada uses 600 standard Cone-Drive speed reducers in its drives

Reflecting the latest in design and equipment, the new Mannesmann Tube Company, Ltd. seamless steel tube mill at the Canadian Soo will produce almost a quarter-million tons of tubing annually. It is the most completely automated tube mill in existence today and can truly be called a "push-button" production plant. The quarter-mile long plant will require an operating force of 500 men, most of them engaged in maintenance activities.

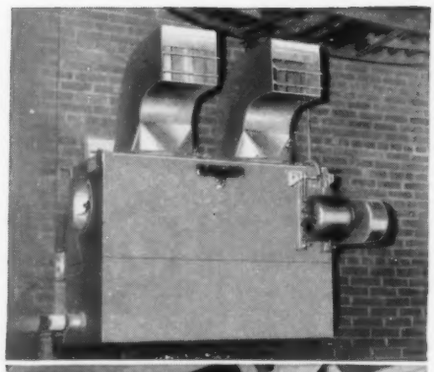
To keep maintenance to a minimum, Mannesmann selected and designed the most rugged equipment possible. One outstanding example is found in their use of Cone-Drive double-enveloping worm gearing in their drive systems. Cone-Drive speed reducers were selected because of their high load-carrying capacity, maximum operating life and minimum service trouble. Experience since the opening of the mill has justified this decision with no operating trouble being reported on the reducers.

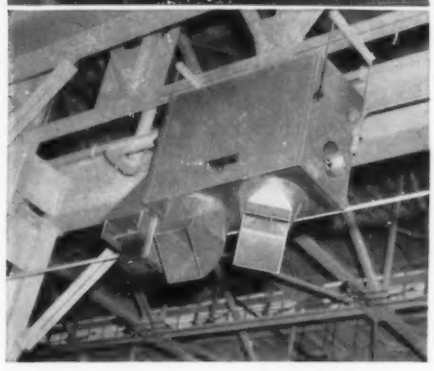
With the exception of one unit, all of the 600 Cone-Drive speed reducers used are standard models with ductile iron housings. Capacities range from one to 60 horsepower. Almost every reducer is operating under some form of severe shock loading and this was another important consideration in their selection by Mannesmann engineers.

CONE-DRIVE GEARS DIVISION MICHIGAN TOOL COMPANY

7171 E. McNichols Road • Detroit 12, Michigan • Telephone: TWinbrook 1-3111

DOUBLE-ENVELOPING WORM GEARSETS | DOUBLE-ENVELOPING WORM GEAR SPEED REDUCERS | DOUBLE REDUCTION WORM GEAR SPEED REDUCERS | DOUBLE-ENVELOPING RIGHT ANGLE GEARMOTORS





At top, conserving productive space in low-ceiling area with a compact "Buffalo" Highboy Unit Heater.

Check the floor space-saving advantages of ceiling-suspended "Buffalo" Lowboy Unit Heater in lower photo.

MAINTENANCE-FREE

"BUFFALO" PACKAGE UNIT HEATERS

INSURANCE AGAINST LEAKAGE IN HIGH-PRESSURE STEAM SYSTEMS

For flexible, economical, efficient "spot-heating" applications, "Buffalo" Breezo-Fin Unit Heaters are doing an outstanding job in plants of every type. The unique design of Breezo-Fin Unit Heaters makes them ideally suited for use in high-pressure steam systems. *There is no possibility of leakage inside the unit.* The one-piece, seamless copper coil runs continuously from inlet to outlet ground joint. This "Buffalo" feature insures you of a positive, leak-tight heating unit for steam pressures up to 250 lbs.

"Buffalo" Breezo-Fin Quality Features:

- **Fins spaced for maximum radiation.**
- **Adjustable louvers aim heat where needed.**
- **Streamlined, attractive appearance.**
- **High-efficiency fans give quiet operation.**
- **One-piece welded motor mounting.**
- **Rugged construction for trouble-free life.**
- **Side connections for compact, low headroom installation.**

"Buffalo" Breezo-Fin Unit Heaters may be the economical, *leak-proof* solution to *your* high-pressure "spot-heating" problems. Write today for Bulletin 3137-E.

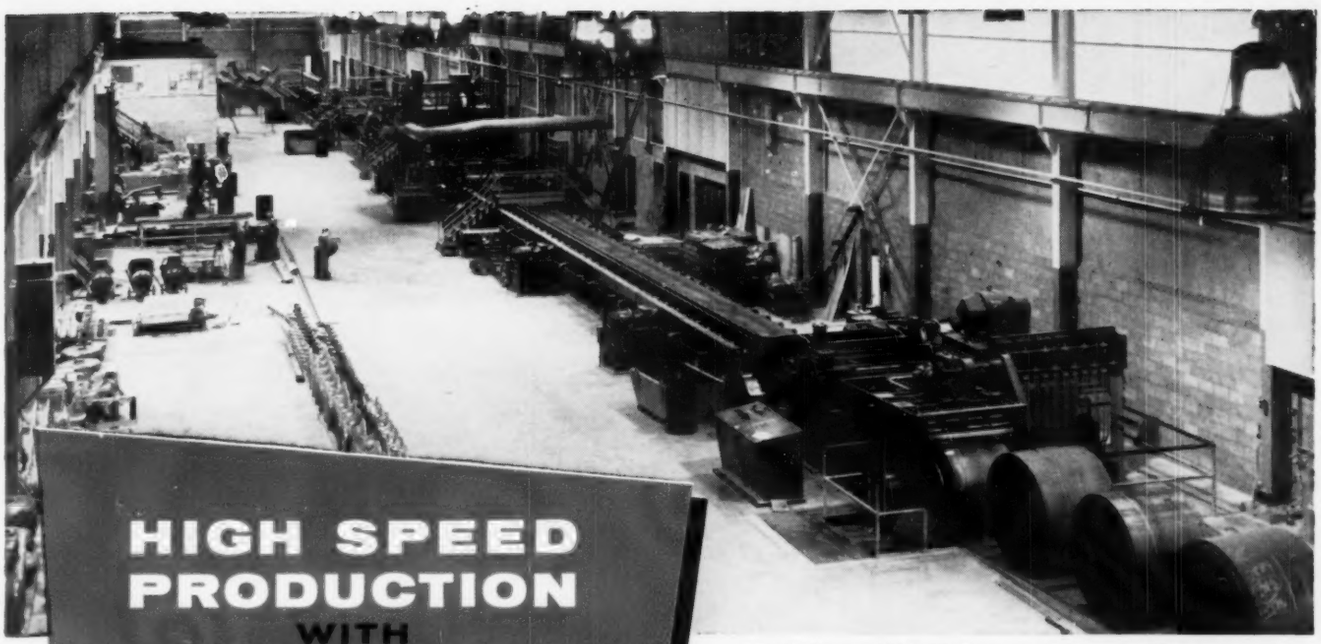
For heating larger plant areas efficiently and economically, dependable "Buffalo" Lowboy and Highboy unit heaters can save space in your plant. See photos above, and write us for Bulletin 3704.

BUFFALO FORGE COMPANY

BUFFALO, NEW YORK

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING



HIGH SPEED PRODUCTION WITH RELIANCE V★S DRIVES

Six Reliance V★S Drives make it possible to operate this complete line as if it were a single machine.

Carloads of pipe are pouring out of the new Edmonton, Alberta plant of Alberta Phoenix Tube & Pipe, Ltd. This $6.5 million installation is producing pipe at unprecedented rates.

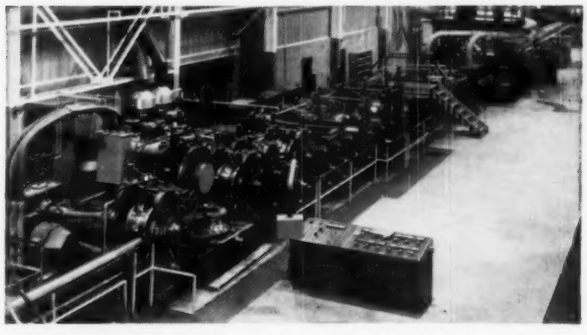
Volume pipe production requires something special in a drive system—one that furnishes precise speed control and instantaneous motor response. A wide stepless range of speeds is provided to handle various pipe diameters and lengths, and all sections of the line operate at the same relative speed.

A team of Reliance Application Engineers, working with the machinery builder, built this specialized drive. This team knows the processes of the steel industry and how to handle the problems involved. Engineering knowledge, backed by the quality of Reliance products, supplied this accurate, simple-to-operate, economical drive.

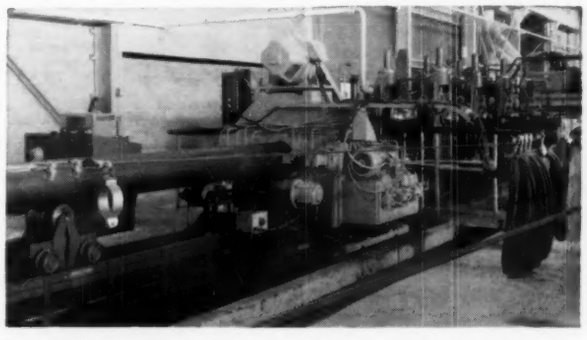
The Reliance Application Engineering Department builds drives for every industry. A team of engineers who are experts on your industry's operation, stand ready to engineer and build the drive for your particular needs.

If you would like more information on this installation, write for Bulletin L-2505.

L-1541



The welding section operator controls the speed of the entire line from this Reliance Pendent Station.

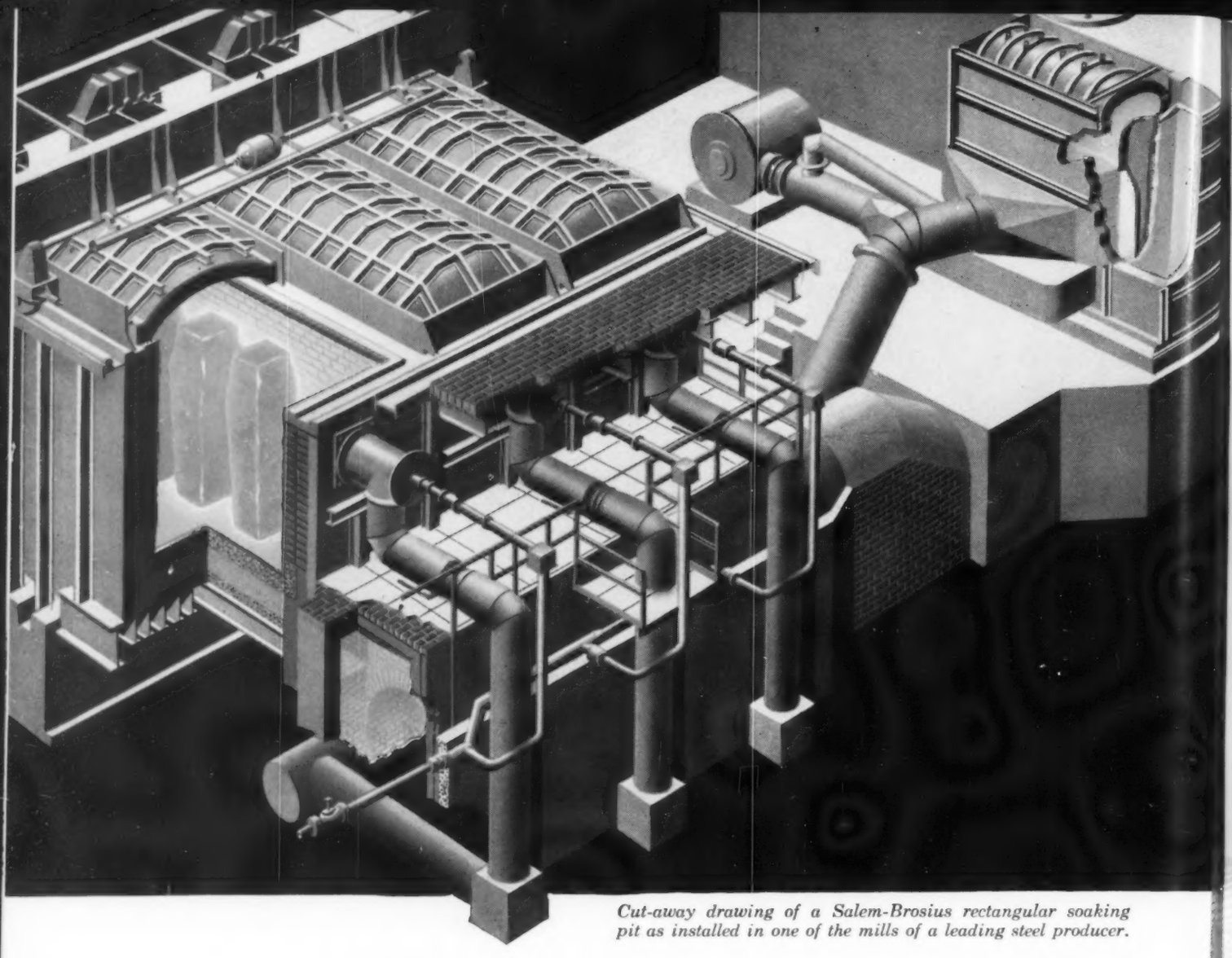


The Reliance V★S Drive on this flying cutoff automatically measures the pipe and controls the movement and speed of the carriage.

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 112A CLEVELAND 17, OHIO · CANDIAN DIVISION: WELLAND, ONTARIO

Sales Offices and Distributors in Principal Cities



Cut-away drawing of a Salem-Brosius rectangular soaking pit as installed in one of the mills of a leading steel producer.

Users are the best salesmen of Salem-Brosius soaking pits

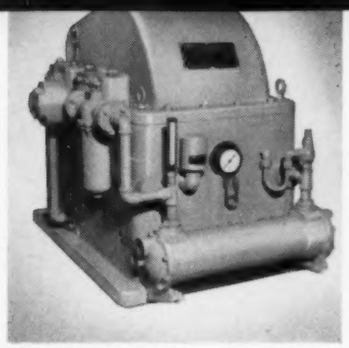
"We have again specified Salem-Brosius rectangular soaking pits for our expansion program," reports an operating official of a major steel company using pits installed by several manufacturers. "The previous installation heated more steel ingots ready for rolling with less fuel consumption, less maintenance cost, and better temperature uniformity than any other type of pit in our plant."

Reports like this are typical, not only about these rectangular soaking pits, but all other Salem-Brosius heating and heat-treating furnaces as well. Salem-Brosius engineers, both here and abroad, possess an enviable record for designing furnaces which produce maximum, high-quality output at minimum operating cost. If your expansion or modernization plans call for ingot soaking pits or any other heating or heat-treating furnaces, Salem-Brosius, Inc. would appreciate an inquiry.

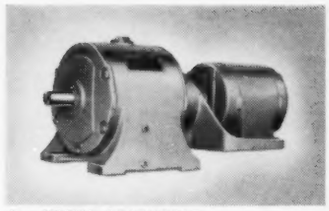
SALEM-BROSIUS, INC.

CARNEGIE, PENNSYLVANIA

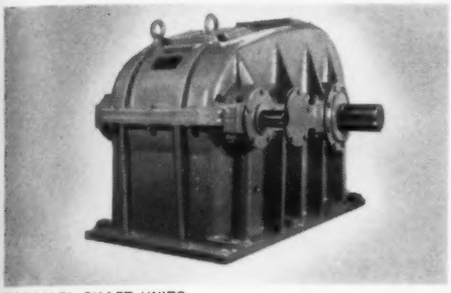
In Canada: Salem Engineering Limited, 1525 Bloor Street West, Toronto, Ontario



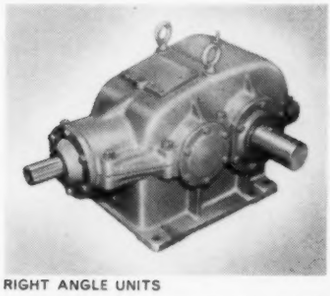
HIGH SPEED UNITS



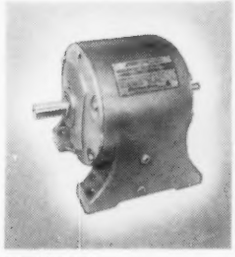
ALL MOTOR GEARMOTOR



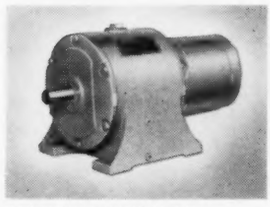
PARALLEL SHAFT UNITS



RIGHT ANGLE UNITS

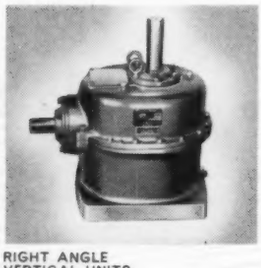


STRAITLINE UNITS

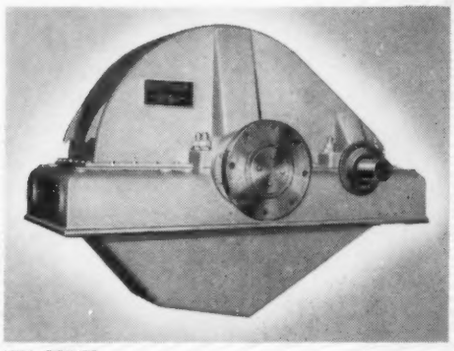


INTEGRAL GEARMOTORS

"INDUSTRIAL MUSCLES" BY WESTERN GEAR CUT YOUR OPERATING COSTS



RIGHT ANGLE VERTICAL UNITS



MILL DRIVES

Western Gear's family of mechanical power transmission products, ranging from gearmotors, speed reducers of all types and shaft arrangements, ratios and horsepowers, to high speed units have been designed and developed over a period of many years. They can do a better job for you, at lower costs, because they incorporate customer proved and preferred features, backed by 70 years of engineering and manufacturing experience at Western Gear. Units range from 1 HP to 50,000 HP, and many modified designs are on file which may exactly suit a custom requirement. Why not use the coupon to get the name of our nearest application engineer or data on any of the drives shown above. No obligation of course!

CALL THE WESTERN GEAR MAN!
Use the adjoining coupon to get his name and address.

"The difference is reliability" • Since 1888

WESTERN GEAR Corporation
ENGINEERS AND MANUFACTURERS

PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.), SEATTLE AND HOUSTON—REPRESENTATIVES IN PRINCIPAL CITIES

5786

Glenn Malme • WESTERN GEAR CORPORATION
P.O. Box 182 • Lynwood, California

please send ☐ name of nearest application engineer
☐ data on_____

name_____

company_____

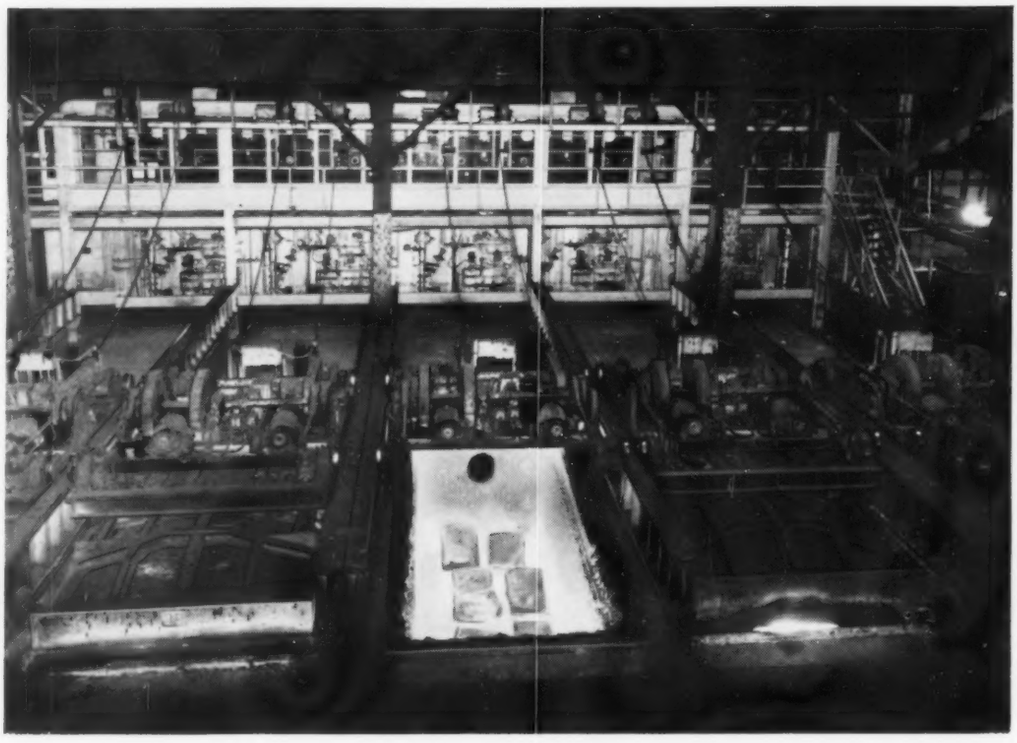
title_____

address_____

city_____ state_____

★ Soaking Pits for Inland Steel Company

★ Combustion Controls by ***ASKANIA***



Looking down upon a row of Salem-Brosius, Inc. soaking pits at Inland Steel Company's No. 3 Blooming Mill

Askania Fuel/Air Ratio and Furnace Pressure Controls— *Accurate, Dependable, Easily Maintained*

One section of the Askania controls regulating fuel/air ratio and furnace pressure on the above soaking pits.

Inland Steel Company officials point to the importance of accurate fuel/air ratio control over a wide range of turn down and precise furnace pressure control to continuously maintain the prescribed combustion conditions for soaking pit operations.

Askania control systems can be depended upon to maintain ideal pit operating conditions...hold maximum production levels...with the minimum amount of attention and the least maintenance.

Askania Regulator Company produces a complete line of soaking pit, blast furnace, arc furnace and other steel mill controls.

For descriptive literature providing detailed information on Askania controls, write to Askania Regulator Company, 246 E. Ontario St., Chicago, Ill.

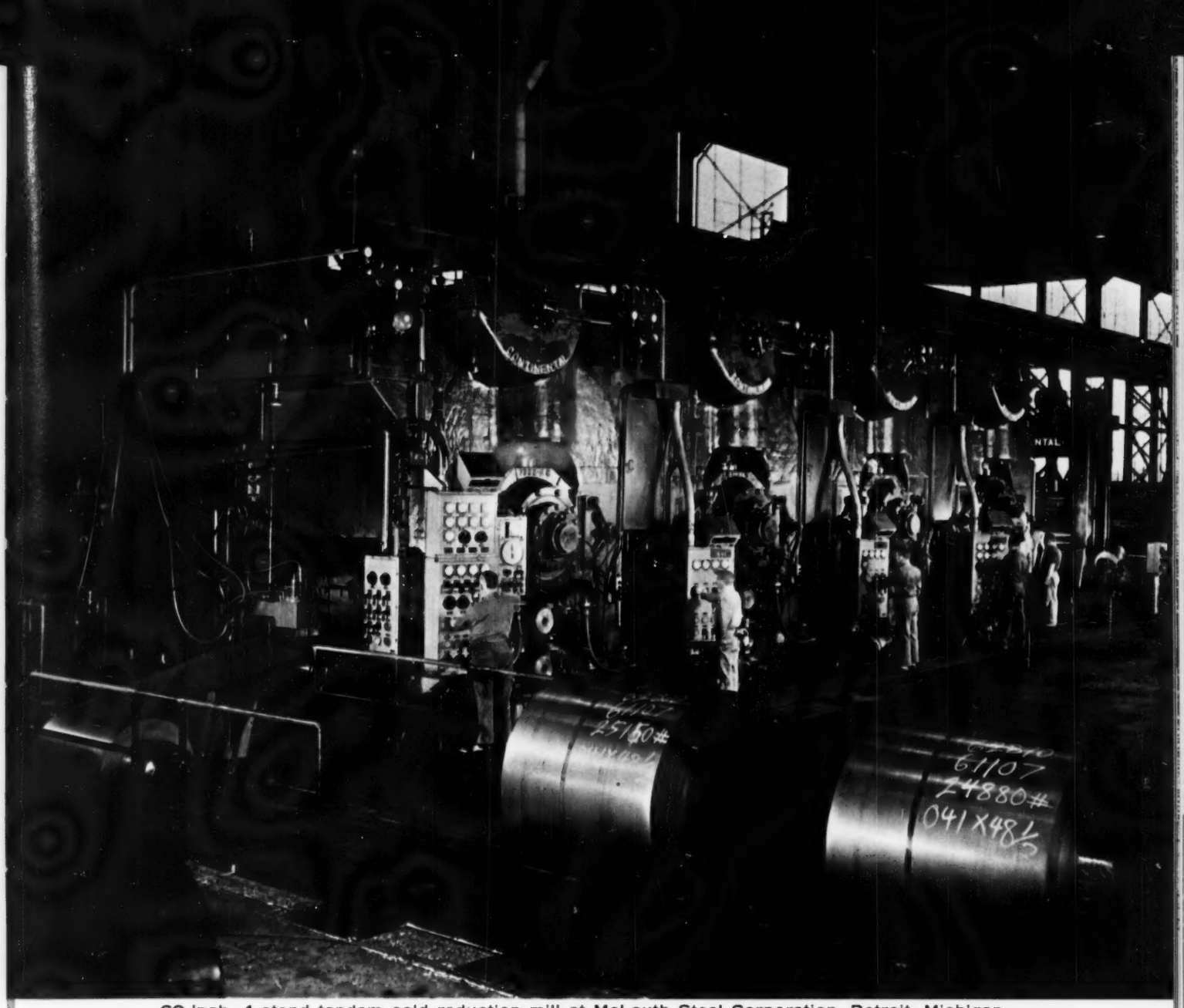
ASKANIA REGULATOR COMPANY

"CONTROLS FOR INDUSTRY"

Hydraulic, Electrohydraulic and Electronic Controls—
Valve Actuators and Cylinders—General System Engineering

A SUBSIDIARY OF
GENERAL PRECISION EQUIPMENT CORPORATION

GPE



60-inch, 4-stand tandem cold reduction mill at McLouth Steel Corporation, Detroit, Michigan

BLAW-KNOX COLD STRIP MILLS

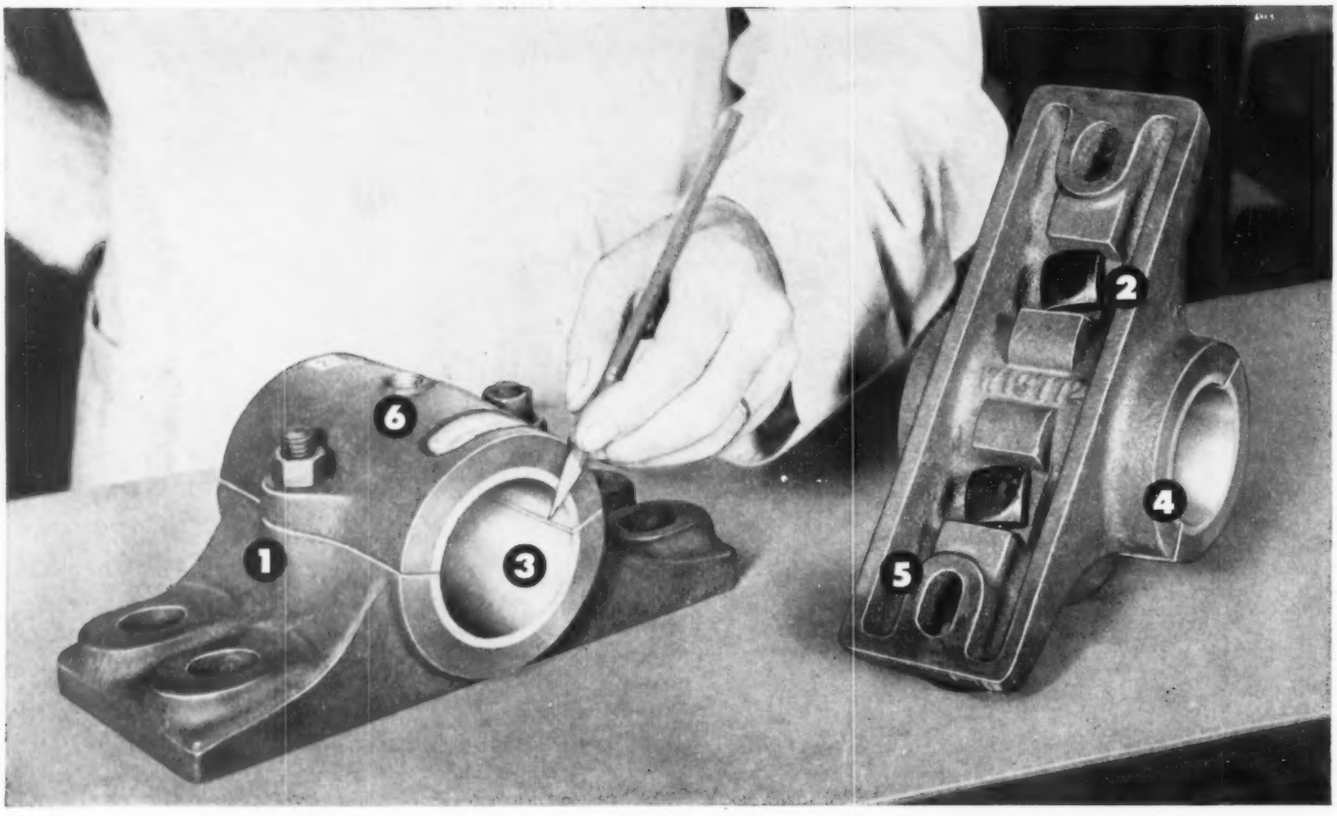
Blaw-Knox designs and builds all types of cold reduction and temper mills for ferrous and non-ferrous work. Other Blaw-Knox equipment for the metals industry includes complete rolling mill installations including all auxiliary equipment for ferrous and non-ferrous metals, iron, alloy iron and steel rolls, Medart cold finishing equipment, carbon and alloy steel castings, fabricated steel plate or cast-weld design weldments, steel plant equipment, and heat and corrosion resisting alloy castings.

BLAW-KNOX

BLAW-KNOX COMPANY

Foundry and Mill Machinery Division
Blaw-Knox Building • 300 Sixth Avenue
Pittsburgh 22, Pennsylvania

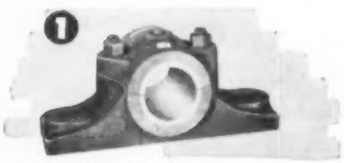
Make this revealing
6-spot check
on babbitted and bronze bearing quality



LINK-BELT offers efficiency-proved features in a complete range of types and sizes

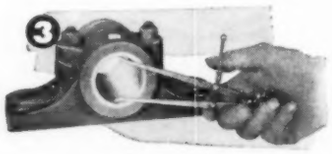
BEFORE you buy babbitted and bronze bearings, look for the features below. They're standard with Link-Belt—a complete range of more than 15 types and over 300 sizes of solid, split, gibbed or angle blocks. In addition, Link-Belt's broad distribution assures off-the-shelf delivery on sizes for ½- to 8-inch shafts, plus a wide variety of take-ups to meet any requirement. And for special applications, bearings can be furnished with cast steel housings.

Each bearing incorporates a heavy-duty babbitt or high-quality bronze. Careful packing provides protection during shipment — decals identify each by serial number and size for re-ordering. See your nearest stock-carrying factory branch store or distributor.



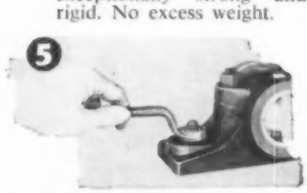
HOUSINGS are of durable cast gray iron . . . compact, exceptionally strong and rigid. No excess weight.

BASES are finished for close tolerance from base to center of bore—assure firm seating on supports.



BORES are finish-machined to close tolerances . . . assure concentricity, accurate fit on the shaft.

ENDS are finished to provide accurate bearing surface for collar or sprocket . . . reduce friction.



BOLT HOLES in base are slotted for easy adjustments and accurate shaft alignment.

LUBRICATION of bearing is provided through grooves and fitting in cap.

LINK-BELT

BABBITTED AND BRONZE BEARINGS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,194

TRANTINYL

GUIDES THE STEEL INDUSTRY

"TRANTINYL" offers a quarter-century of metallurgical experience. "TRANTINYL" patented alloys were developed to function in specific operations where guides are required to resist wear and abrasion. Users of "TRANTINYL" alloys are astounded at the tonnage rolled over one set of guides.

Join the many satisfied users of "TRANTINYL."

ROLLING MILLS:
bar, hoop, strip, shape mill guides; and rollers.

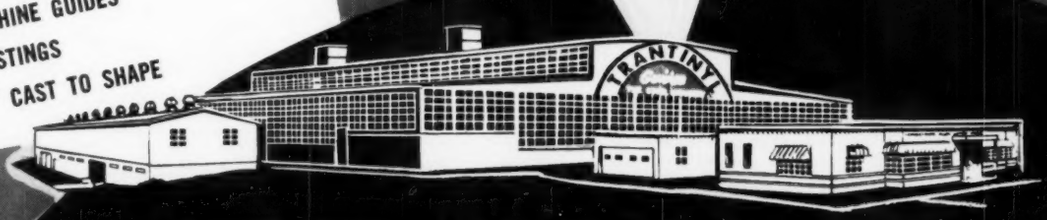
SEAMLESS TUBE MILLS:
guide shoes, rolling mill plugs and rolls, piercer points, etc.

ELECTRIC WELD TUBE MILL:
forming rolls, planishing rolls, tool holders, etc.

STRAIGHTENING MACHINE GUIDES

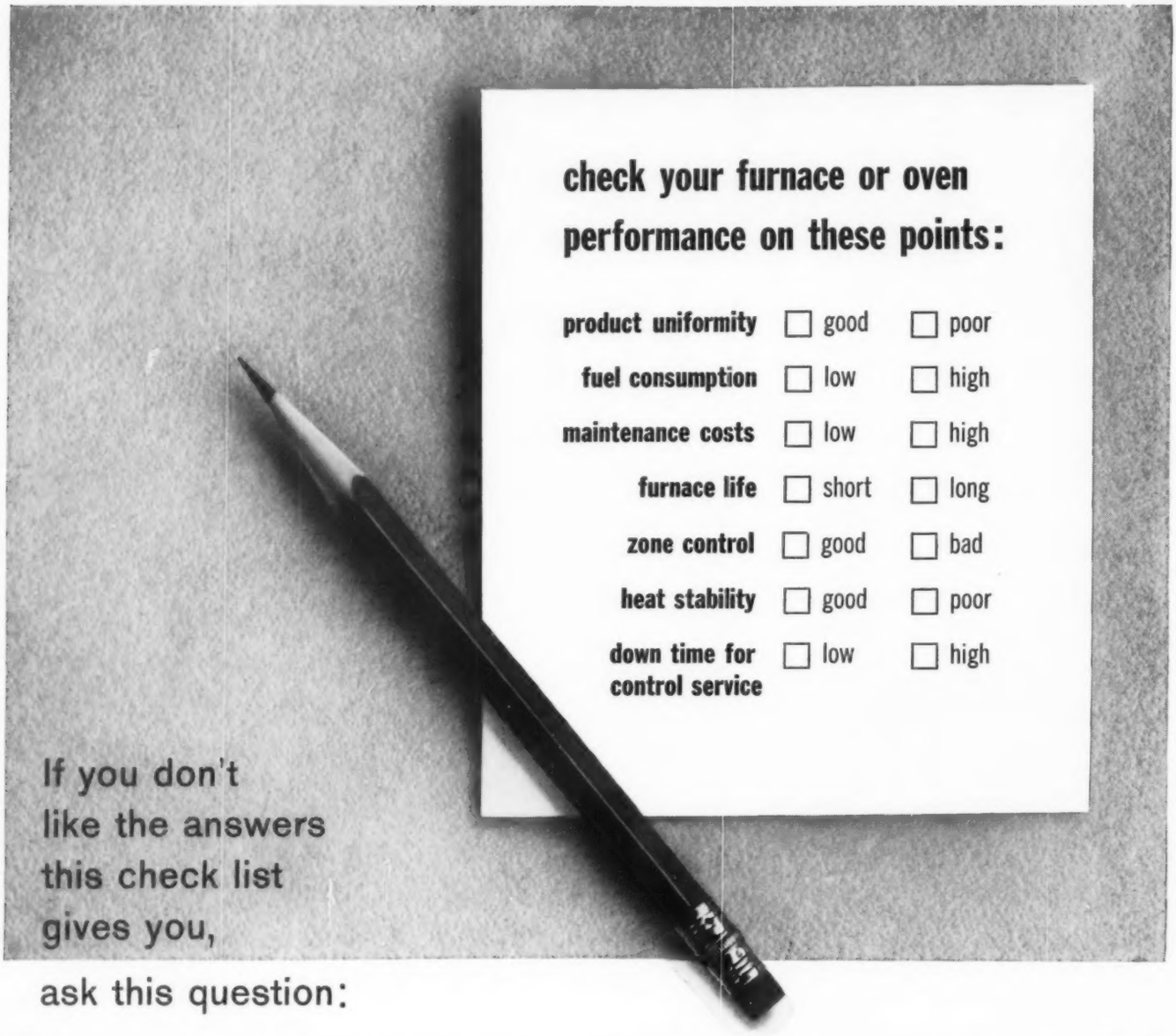
HEAT RESISTING CASTINGS

"TRANTINYL No. 1" CAST TO SHAPE



Youngstown Alloy Casting Corporation

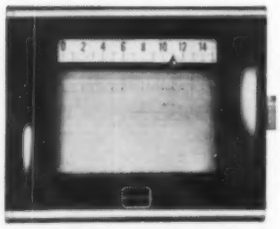
Youngstown, Ohio


check your furnace or oven
performance on these points:
product uniformity ☐ good ☐ poor
fuel consumption ☐ low ☐ high
maintenance costs ☐ low ☐ high
furnace life ☐ short ☐ long
zone control ☐ good ☐ bad
heat stability ☐ good ☐ poor
down time for control service ☐ low ☐ high
If you don't like the answers this check list gives you,

ask this question:

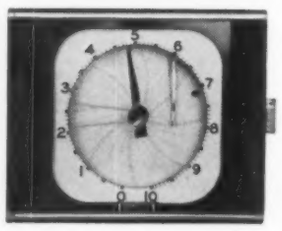
"Are my furnace controls obsolete?"

Strip-chart model



BRISTOL DYNAMASTER* ELECTRONIC PYROMETER CONTROLLERS

Round-chart model



Outmoded instruments can cost you money, lower product quality, and cut output of any furnace or oven.

New Bristol ideas are revolutionizing many older concepts of automatic control. *Bristol's great strides in electronic potentiometer development have made obsolete many instruments only a few years old.*

New product developments and production methods are placing new and unusual demands on furnace instruments and controls today.

That's why it pays to find out about the latest Bristol engineering developments before you buy another instrument or control. Take Continuous Standardization, for example—a feature you'll want on *your* next pyrometer controller. This exclusive Bristol feature, found only on Dynamaster* Pyrometers, eliminates dry cells but retains the accuracy-insuring standard cell. There's no interruption to control for standardization; no batteries to replace.

Continuous Standardization is just *one* recent Bristol development in the field of pyrometry and temperature control. To find out more, write: The Bristol Company, 123 Bristol Road, Waterbury 20, Conn.

7.16

BRISTOL *TRAIL-BLAZERS IN PROCESS AUTOMATION*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

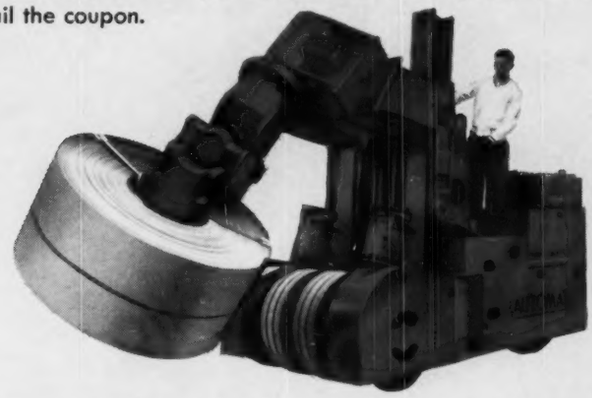
*T. M. Reg. U. S. Pat. Off.

BEST OF THE HEAVIES...

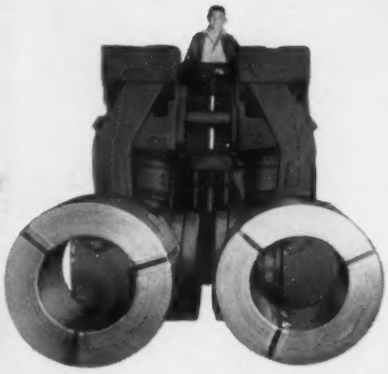
SERIES MF-ELBOLIFT: Works on leverage principle new to lift truck design... eliminates entire mast assembly. Carrying a load of 15,000 lbs., the Elbolift passes easily through any 78" boxcar door... will right-angle stack a 52" long load up to 120" high comfortably in a 13' 8" aisle. CAPACITIES: 12,000 to 20,000 pounds.

Automatic...
Most Complete Line of Steel and Die Handling Equipment
Capacities up to 110,000 lbs. or more

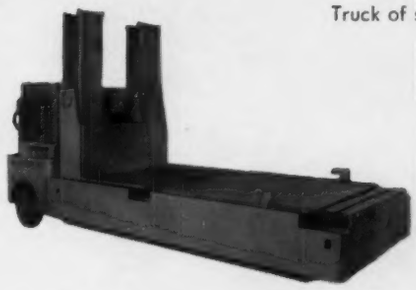
In the heavyweight division of materials handling, no other line matches the versatility and range of Automatic's heavy duty trucks. This is the direct result of many years of specialized engineering and manufacturing experience in the coil and die handling field. The five examples shown here comprise only a small sampling of the wide range of heavy duty handling requirements served by Automatic equipment. So don't hesitate to call us in on any problem involving weights up to any practical limit. No obligation, of course. Just mail the coupon.



COIL-UPENDER ATTACHMENT: Picks up coil in vertical position and rotates to horizontal or vice versa. Holds coil securely throughout rotation... prevents telescoping. Handles up to 60,000 lbs. Now available on Automatic HR Series or as an attachment for any Automatic Truck of suitable design and capacity.



SKYLIFT GIANT: Heavy duty mast type truck available with either forks or ram. Model shown here has split ram to handle either 1 or 2 coils at a time. CAPACITIES: 20,000 through 80,000 pounds or more.



SERIES TLO: First heavy duty die handlers ever made with completely hydraulic loading, unloading and lift. Bullards move much faster and smoother than in any mechanical system... unloads at end or either side to meet any requirements of space and accessibility. CAPACITIES: 4,000 to 110,000 pounds or more.

MODEL TLO-10: Shortest, most compact 20,000 pound die-handler made... fastest, easiest to maneuver, especially in narrow aisles. Hydraulically operated lift, loading and unloading.

Automatic Electric Industrial Trucks Cost Less to Own... Less to Operate

AUTOMATIC TRANSPORTATION COMPANY
Division of The Yale & Towne Manufacturing Company
47 West 87th Street—Dept. B8—Chicago 20, Illinois

Electric Automatic Industrial Trucks

WORLD'S LARGEST EXCLUSIVE BUILDERS OF ELECTRIC-DRIVEN INDUSTRIAL TRUCKS

AUTOMATIC TRANSPORTATION COMPANY
Division of The Yale & Towne Manufacturing Company
47 West 87th Street, Dept. B8, Chicago 20, Illinois

☐ Please rush me complete specifications on following Automatic heavy duty equipment.

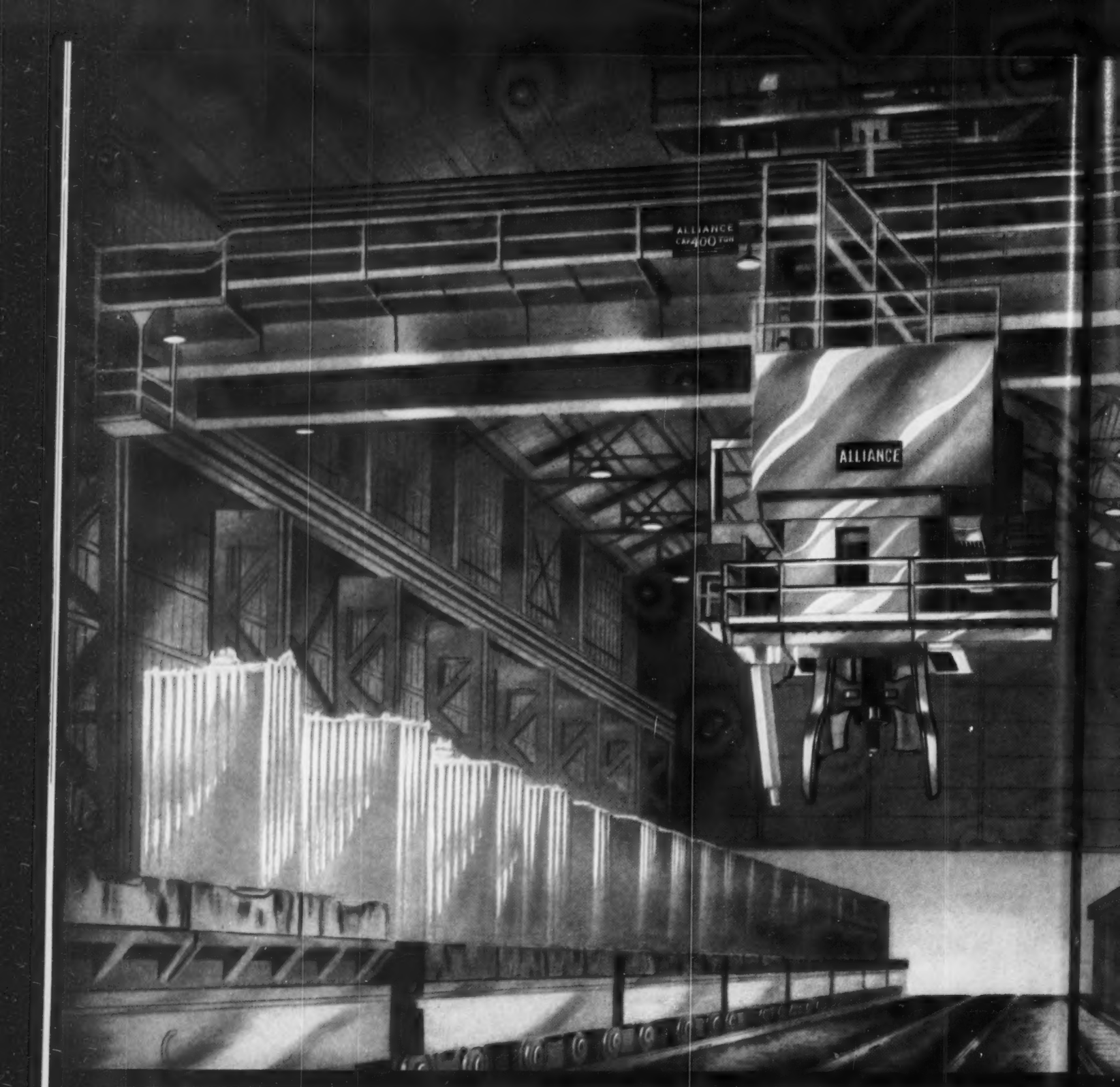
MODELS.....

Your Name.....Title.....

Firm.....

Address.....

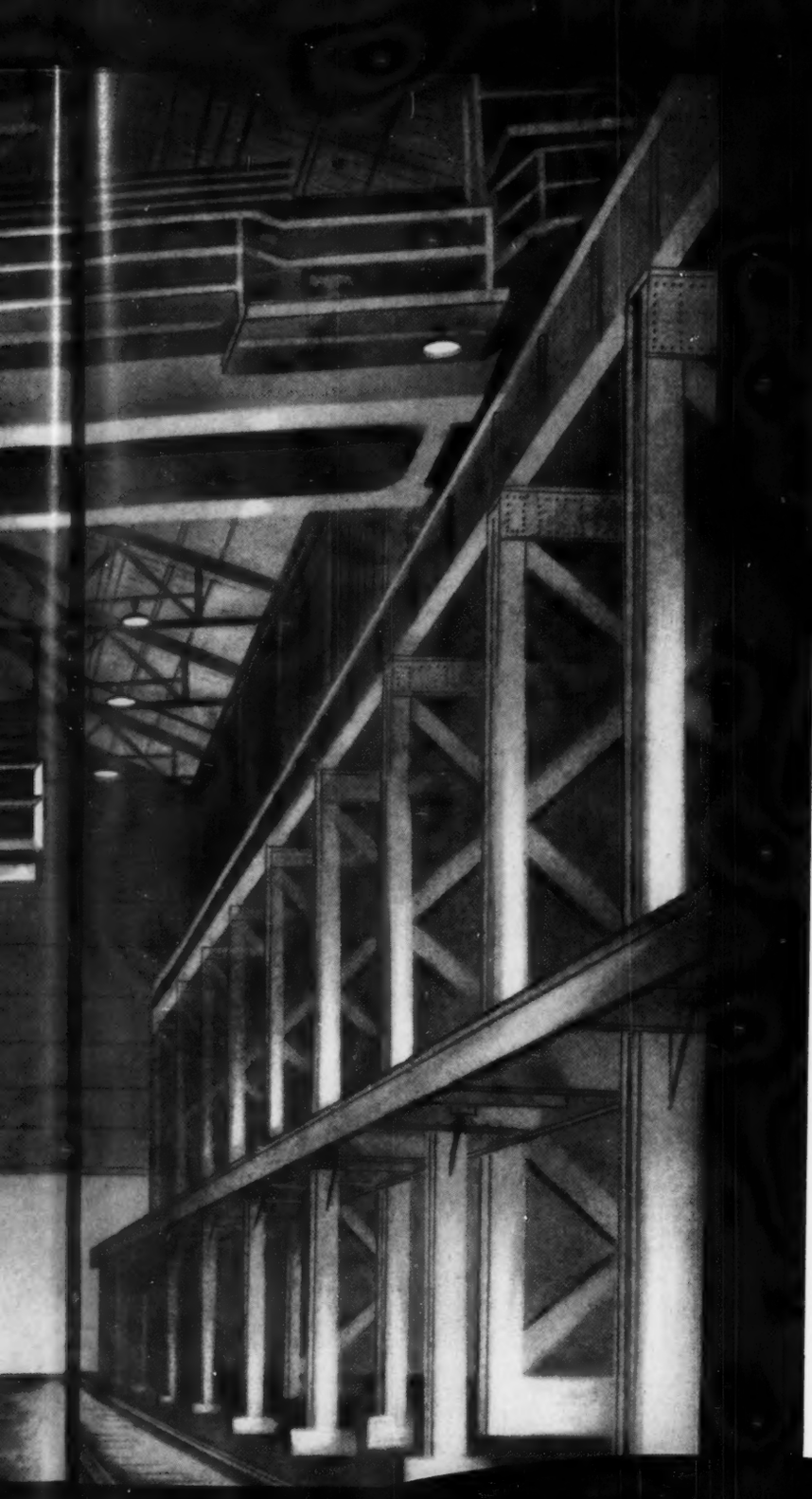
City & Zone.....State.....



THE WORLD'S LARGEST STRIPPER CRANE

• This 400-ton Alliance push-pull Stripper Crane is the world's largest. It can exert 2,400,000 pounds' pressure to strip moulds from ingots — cleanly and safely. The patented Impact Stool Loosener speeds up the stripping operation. The stripping mechanization has a nominal rating of 400 tons but is designed to stand forces of 1200 tons. Its many exclusive design features are a result of Alliance's knowledge of mill problems and requirements. They design the world's biggest cranes, manipulators and special machinery. Their experience assures you the best in modern design. A letter, wire or phone call will put your problems into the hands of The World's Largest Builders of the World's Largest Cranes.

THE ALLIANCE MACHINE COMPANY •



EXCLUSIVE with ALLIANCE

The Alliance Impact Stool Loosener makes your stripper crane more useful, more efficient and saves wear and tear on the crane and ingot buggies. The Impact Stool Loosener can be installed on most stripper cranes now in your service.

Alliance

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION • COKE PUSHERS

MAIN OFFICE • ALLIANCE, OHIO

UNEXCELLED

Giant castings weighing several tons often require minute accuracy in machining. Such precision is an every day occurrence in our shop. If it's a machining job that's big and tough to handle—Pittsburgh is *unexcelled* in performance. Highly skilled personnel plus our wide range of equipment will pay off for you on king size machining problems. (4 High Mill Housing Illustrated)

"Electric and Open Hearth Steel Castings from 1 lb. to 100 tons"

Pittsburgh
ENGINEERING & MACHINE CO.

P. O. BOX 986, PITTSBURGH 30, PENNSYLVANIA
PLANT AT GLASSPORT, PENNSYLVANIA
Division of Pittsburgh Steel Foundry Corporation

NEW EC&M GIVES YOU VERTICAL MASTER SWITCH REAL FLEXIBILITY!

Built-in Features Make Type VM Best for Many Jobs

MANY FORMS AVAILABLE • Supplied for either right- or left-hand operation—in four sizes to accommodate maximums of 6, 9, 12, and 16 circuits—with or without enclosure.

WIDE VARIETY OF APPLICATIONS • Small size makes it a "natural" for jobs where space is limited—can be mounted adjacent to operator's chair—ideal for air-conditioned crane cabs—for ore bridge installations—for any desk-mounted application.

SUPERIOR DESIGN FEATURES • Narrow width and short throw reduce operator fatigue—mill-type construction throughout—optional features include spring return to OFF point, pushbutton contact in handle. Offers all of the fine construction features of the well-known EC&M cam master switch.

Write for Bulletin 9004 VM

TYPE CM MASTER SWITCH

• This service-proven EC&M cam master switch is designed for surface-mounting on all mill, crane, and hoist applications. Narrow width permits close grouping of several master switches within easy reach of the operator.

FOR BASIC STEEL MAKING, IT'S EC&M CONTROL

THE ELECTRIC CONTROLLER & MFG. CO.

A DIVISION OF THE SQUARE D COMPANY

CLEVELAND 28 • OHIO

9813

These Rust-Oleum differences

SAVE TIME, MONEY, METAL!

Here are just a few of the many Rust-Oleum differences that save *time, money, metal*—and help to make present equipment last longer.

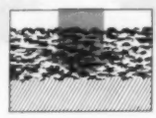
Saves money—because the Rust-Oleum 769 Damp-Proof Red Primer goes right over sound rusted surfaces after wirebrushing rust scale and loose rust away—usually eliminating costly surface preparation. So easy to use that one man often does the work of two. *Saves money, too*—because Rust-Oleum provides approximately 30% more coverage than most ordinary materials, depending upon the condition and porosity of the surface. *Saves metal*—because Rust-Oleum's specially-processed fish oil vehicle penetrates rust to bare metal, driving out the air and moisture. Attractive Rust-Oleum finish coatings provide lasting beauty in the color of your choice.

See *proof* of performance with your own Rust-Oleum Test Sample. See its smooth, self-leveling action . . . see how you can save rusted metal and beautify as you protect. Your letterhead attached to the coupon on the opposite page will bring your FREE Test Sample. We want you to try it yourself under your own rust-producing conditions. One brushful tells more than a thousand words.

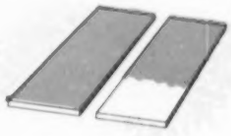
PROVED THROUGHOUT INDUSTRY FOR OVER THIRTY-FIVE YEARS

AVAILABLE IN PRACTICALLY ALL COLORS

EASILY APPLIED BY BRUSH, SPRAY, OR DIP



PENETRATES RUST TO BARE METAL



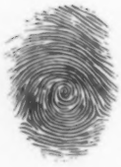
UP TO 30% GREATER COVERAGE

ONE MAN OFTEN DOES THE WORK OF TWO

STRETCH MAINTENANCE BUDGETS SEASON-TO-SEASON

UTILIZES SPECIALLY-PROCESSED FISH OIL VEHICLE

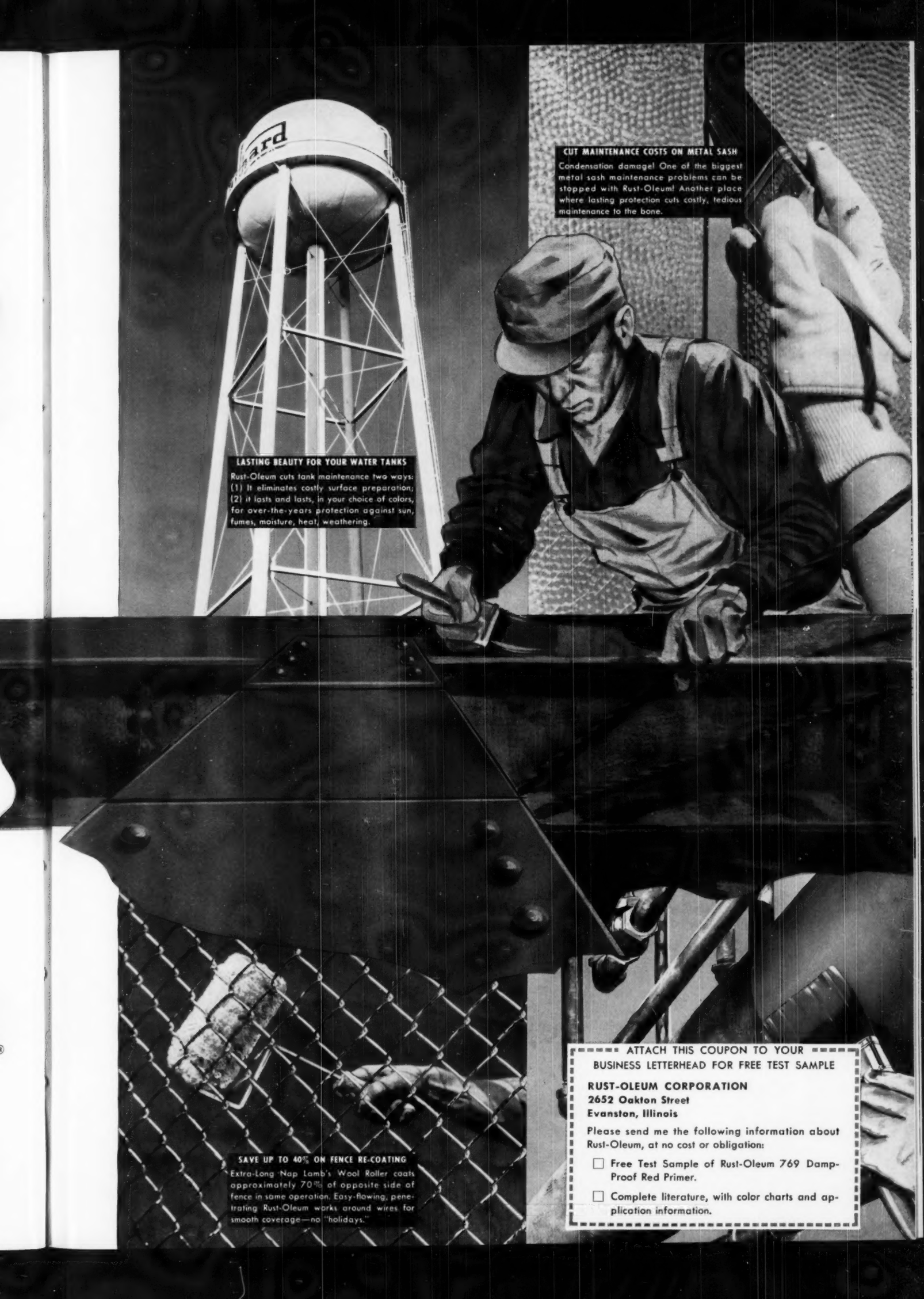
RUST-OLEUM®



Distinctive as your own fingerprint.
Accept no substitute.

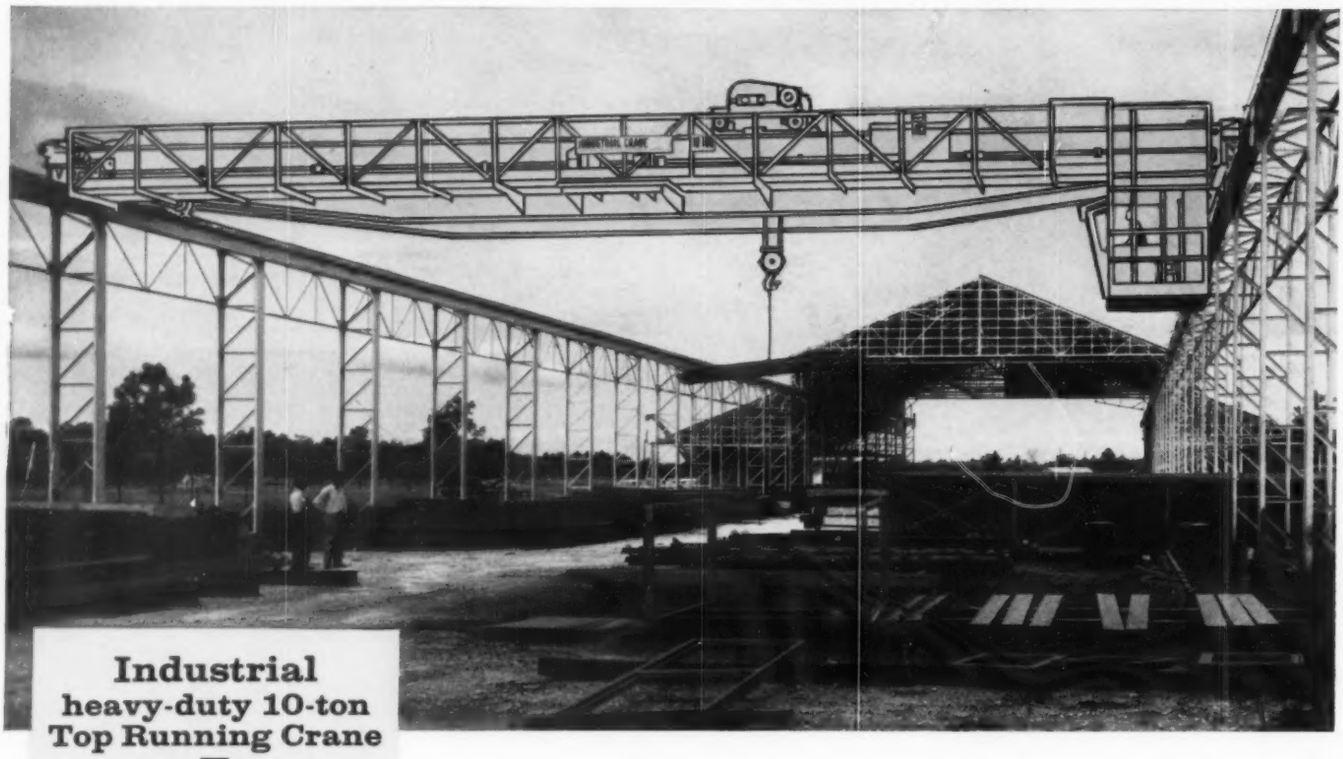
STOPS RUST!®

Prompt delivery from
Industrial Distributor stocks.


LASTING BEAUTY FOR YOUR WATER TANKS
Rust-Oleum cuts tank maintenance two ways: (1) It eliminates costly surface preparation; (2) it lasts and lasts, in your choice of colors, for over-the-years protection against sun, fumes, moisture, heat, weathering.
CUT MAINTENANCE COSTS ON METAL SASH
Condensation damage! One of the biggest metal sash maintenance problems can be stopped with Rust-Oleum! Another place where lasting protection cuts costly, tedious maintenance to the bone.
SAVE UP TO 40% ON FENCE RE-COATING
Extra-Long Nap Lamb's Wool Roller coats approximately 70% of opposite side of fence in same operation. Easy-flowing, penetrating Rust-Oleum works around wires for smooth coverage—no "holidays."
ATTACH THIS COUPON TO YOUR BUSINESS LETTERHEAD FOR FREE TEST SAMPLE
RUST-OLEUM CORPORATION
2652 Oakton Street
Evanston, Illinois
Please send me the following information about Rust-Oleum, at no cost or obligation:
☐ Free Test Sample of Rust-Oleum 769 Damp-Proof Red Primer.
☐ Complete literature, with color charts and application information.

MORE ECONOMICAL HANDLING

at this steel storage yard . . .



Industrial
heavy-duty 10-ton Top Running Crane

another in the versatile Industrial line.

Heavy duty roller bearings throughout.

Precision machined components.

Welded box girder construction.

Rolled forged bridge and trolley wheels.

Wide choice of hoist controls.

Full-length walkways and completely decked trolley.

Full-vision operator's cab.

. . . thanks to the modern design of this

Industrial

HEAVY-DUTY CRANE

It takes smooth running, ruggedly built equipment to keep steel moving in and out of this yard with minimum effort. That's why this southern warehouse chose **Industrial** after a careful study of all overhead cranes.

Industrial's modern "heavy duty" crane designs incorporating the latest components, plus precision manufacture means better performance, smoother operation and greater overall savings to you.

For your next crane, it will pay you to consult Industrial.

Industrial CRANES

HDB-357C

INDUSTRIAL CRANE & HOIST
INGERSOLL PRODUCTS DIV. BORG-WARNER CORP.
1600 S. PAULINA STREET, CHICAGO 8, ILLINOIS
Export Sales: Borg-Warner International, 36 South Wabash Ave., Chicago 3, Illinois

MAINTENANCE

. . . of electric furnaces is a man-sized job. The men who know their furnaces know how to keep them on the go. They also know that a **GLC graphite electrode column with the "weld-strength" Unitrode® nipple** makes better steels at lower cost.

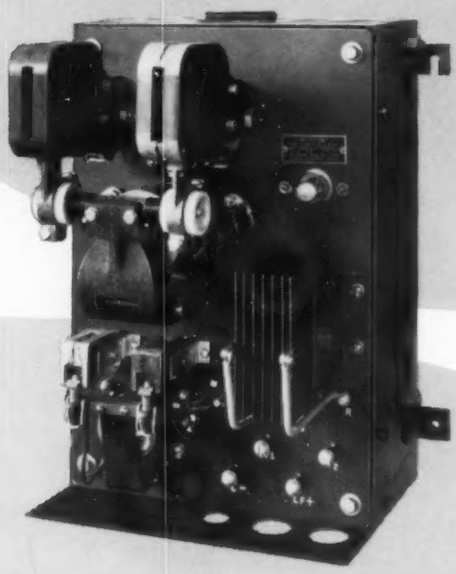
FREE—*This illustration of one of the skills employed by the men who make the metals has been handsomely reproduced with no advertising text. We will be pleased to send you one of these reproductions with our compliments. Simply write to Dept. E-2.*

ELECTRODE GLC® DIVISION

GREAT LAKES CARBON CORPORATION

18 EAST 48TH STREET, NEW YORK 17, N.Y. OFFICES IN PRINCIPAL CITIES

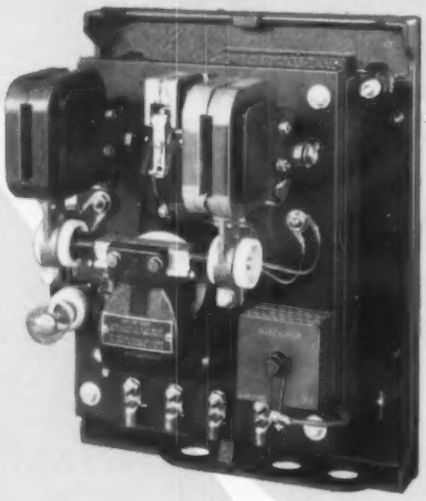
Ohio RD2 Controller (case not shown)



for better performance
it's Ohio Magnets—
especially when used with

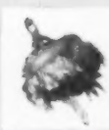
OHIO MAGNET CONTROLLERS

Ohio RD1 Controller (case not shown)



Size for size, Ohio Magnets lift larger loads over longer periods—*particularly when used with Ohio Magnet Controllers.* For Ohio Magnet Controllers are of the high-efficiency, instantaneous-discharge type for any standard or special line voltage from 36 to 250 volts DC. Specify Ohio RD1 Controllers for 35-100 amps, Ohio RD2 Controllers for 75-150 amps—and get better magnet performance. Check Yellow Pages for your nearest Ohio Electric representative or contact Ohio plant for full information.

AA-3968



ohio ELECTRIC

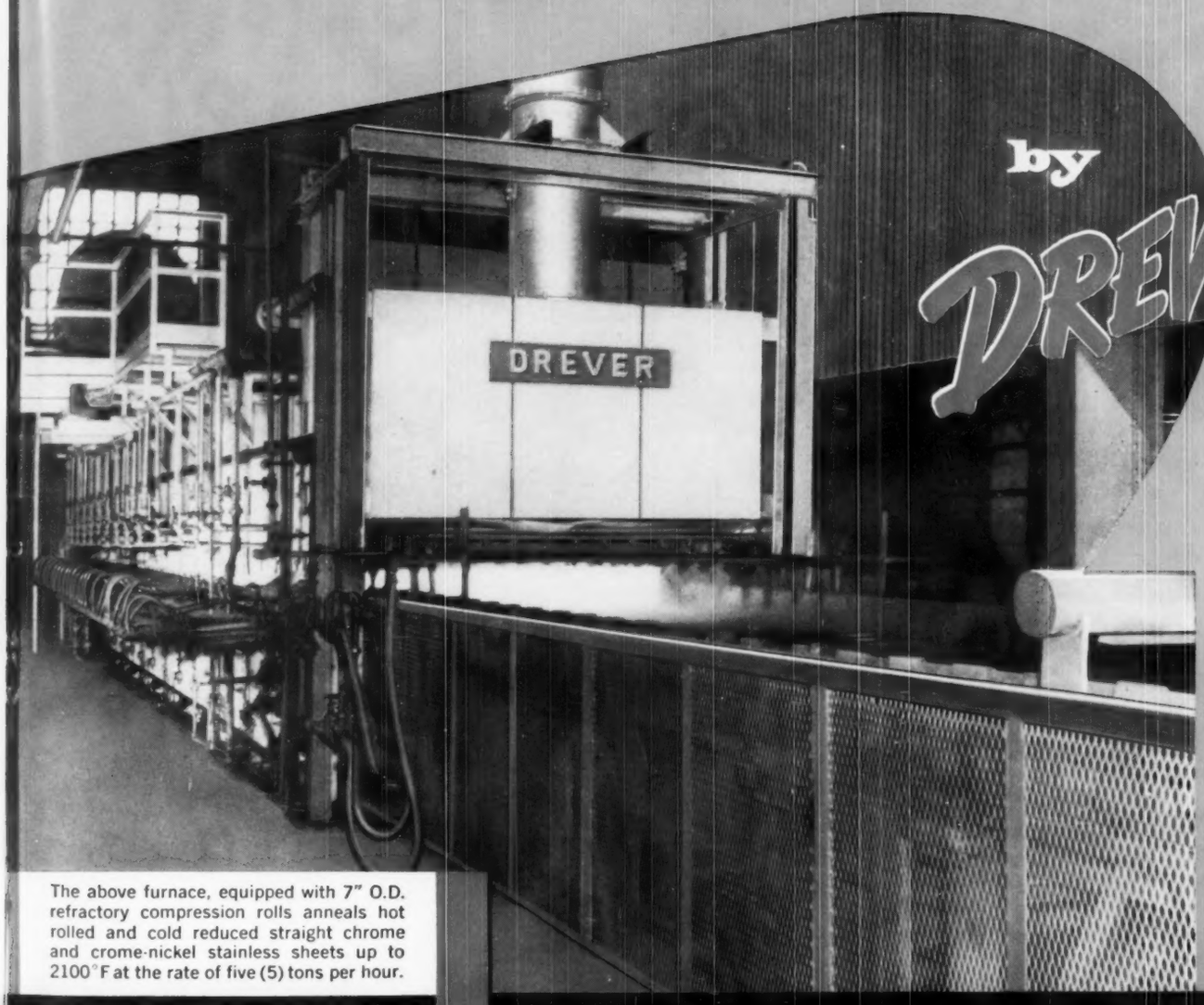
Chester Bland
President

THE OHIO ELECTRIC MFG. CO.
5400 Dunham Road • Maple Heights • Cleveland, Ohio

Ohio Also Makes Separation Magnets
Nail Making Machines • Fractional
Horsepower, Shell and Torque Motors

ROLLER HEARTH
FURNACES

for Operation at 2300°F
Utilizing Drever Refractory Compression Rolls



by DREVER

The above furnace, equipped with 7" O.D. refractory compression rolls anneals hot rolled and cold reduced straight chrome and crome-nickel stainless sheets up to 2100°F at the rate of five (5) tons per hour.

The success in utilizing the Drever Refractory Compression Roll in annealing stainless steels has been attributed to the roll strength and its resistance to pickup which completely eliminates the necessity of using rider sheets. The refractory rolls are prestressed and consist of silicon carbide sections retained by spring loaded alloy ends to allow for expansion and to provide axial forces to insure structural stability under rated load. Furnaces have been installed with roll sizes varying from 4½" O.D. x 20½" long to 14" O.D. x 14'-6" long.

In addition to annealing stainless steel sheets, plates, bars and tubing, materials have been successfully heat treated at 2300°F. Avail yourself of the experience of Drever Company engineers in solving your stainless steel annealing problems.

DREVER COMPANY

RED LION ROAD and PHILMONT AVE., BETHAYRES, PA.

FREE YODER BOOKS OFFER "KNOW-HOW" ON ROLL FORMING • TUBE MAKING • SLITTING

COLD-ROLL FORMING

Structural, ornamental and tubular shapes from stock up to ½" thick. Surface finish, uniformity, stock selection and characteristics, plating problems, production costs, end uses and applications. Auxiliary automatic operations including perforating, notching, welding, coiling, embossing. 88 pages, fully charted and illustrated.

PIPE AND TUBE MAKING

Ferrous or non-ferrous, electric weld, resistance and induction or gas types. Small or large diameter. Tooling, welding, stock ranges, personnel training, quality and tolerance control, speeds, power consumption, annual production rating charts. 64 pages, fully illustrated.

SLITTING

Operating techniques, time studies, analyses of operating cycles, coil handling, scrap disposal, selection of slitters and setting up of slitting lines, including coilers and recoilers. Advantages of slitting and how to compute "profit-point". 76 pages, fully illustrated.

Any or all of these books are free upon request. Send for your copies today . . . Ask for them by title.

THE YODER COMPANY

5495 WALWORTH AVE. • CLEVELAND, OHIO

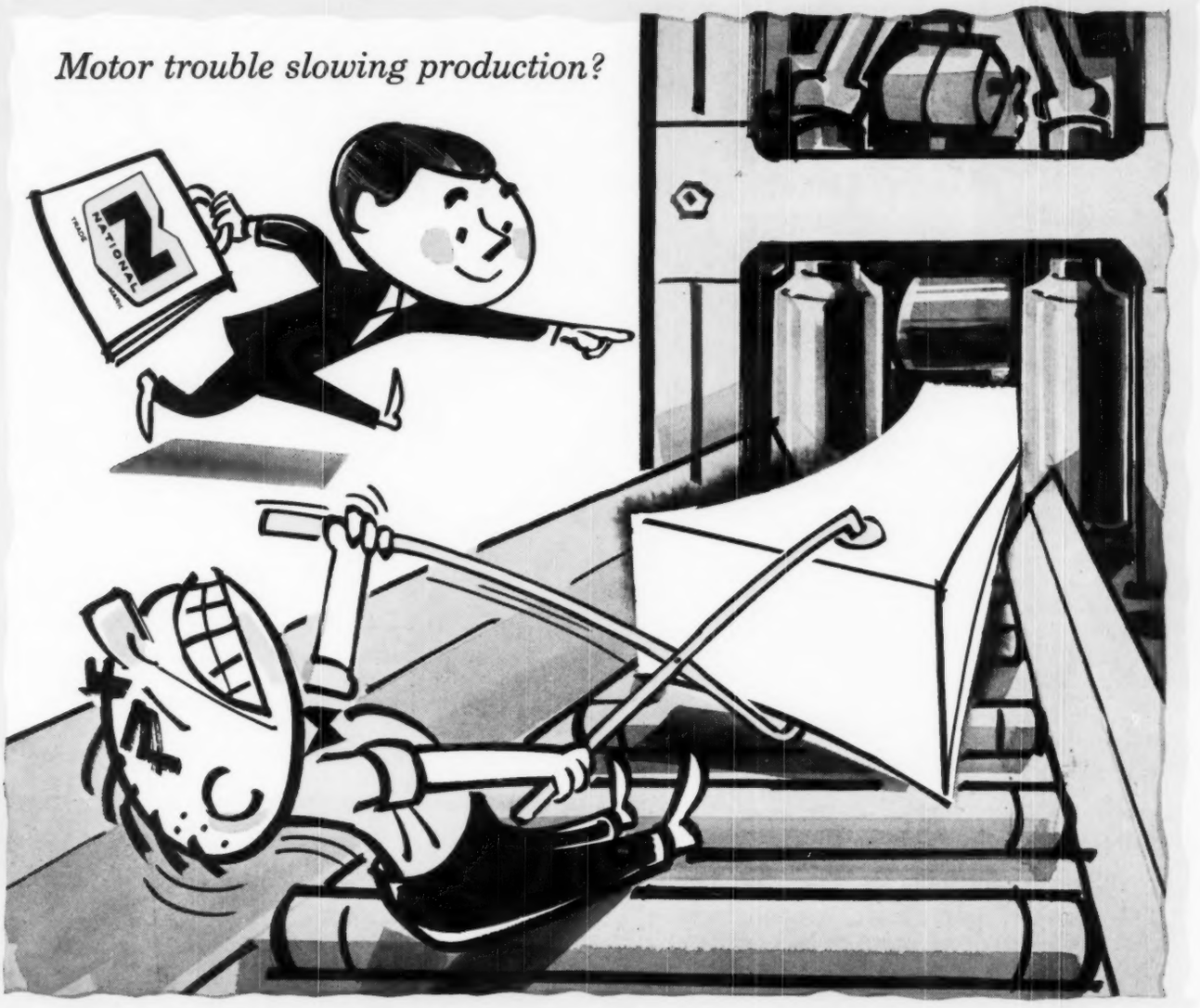
ENGINEERING **YODER** MANUFACTURING

COLD ROLL FORMING MACHINES

PIPE AND TUBE MILLS (ferrous or non-ferrous)

ROTARY SLITTING LINES

Motor trouble slowing production?



Your NATIONAL brush man helped solve this slowdown problem!

JOHN BEHEN

Motor trouble at this 44″ steel mill caused one costly slowdown after another, says "National" Carbon Brush Man, John Behen. Source of the production trouble – excessive film build-up on one of the mill's edger motors.

The mill tried several brushes to alleviate this condition but with no success. They called in John Behen who analyzed the operation and recommended the proper "National" brush grade. *Result:* a 100 ton increase in daily production thanks to trouble-free motor performance. Incidentally, John went on to solve similiar brush problems on 3 of the steel mill's 5,000 amp motor-generator units.

John Behen and his fellow "National" Carbon Brush Men have been solving industrial brush problems for years. Their experience and training – backed by "National" *long term brush development* – make them the logical consultants on any industrial brush problem.

Call your "National" Carbon Brush Man today. Or write National Carbon Company, Division of Union Carbide Corporation, 30 E. 42nd St., New York 17, N.Y.

The terms "National", "N" and Shield Device, and "Union Carbide" are registered trade-marks of Union Carbide Corporation

NATIONAL CARBON COMPANY • Division of Union Carbide Corporation • 30 East 42nd Street, New York 17, N. Y.

UNION CARBIDE

Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco. *In Canada:* Union Carbide Canada Limited, Toronto.

Lectromelt-Demag

electric smelting furnaces

Now...world-famous
Demag design
built by Lectromelt*
Pittsburgh, U.S.A.

Demag design has no equal for smelting operations . . . and now these way-ahead furnaces are constructed for you by Lectromelt, America's outstanding producer of electric furnaces. The unmatched Lectromelt-Demag combination of skills affords new highs in smelting efficiency, economy and safety.

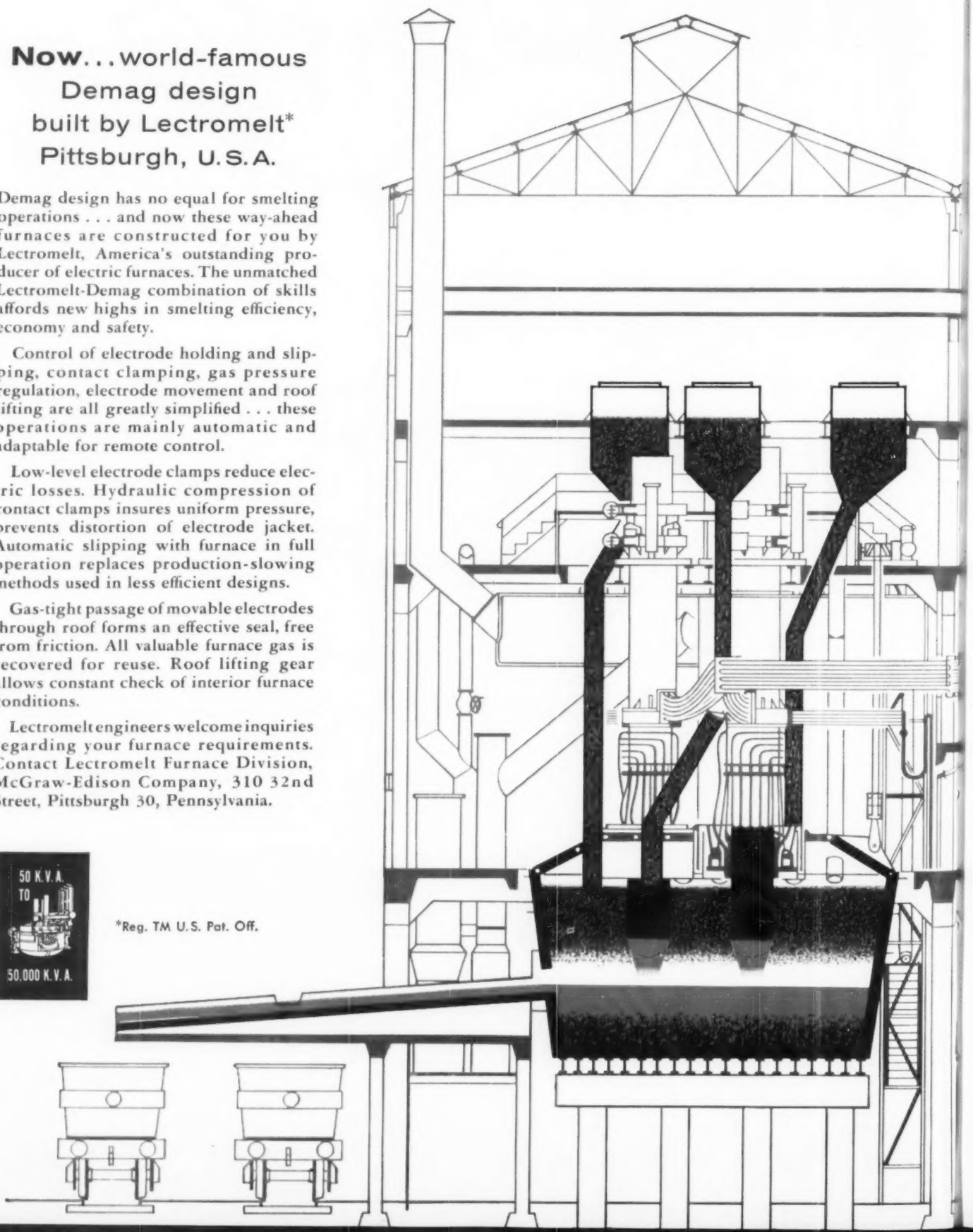
Control of electrode holding and slipping, contact clamping, gas pressure regulation, electrode movement and roof lifting are all greatly simplified . . . these operations are mainly automatic and adaptable for remote control.

Low-level electrode clamps reduce electric losses. Hydraulic compression of contact clamps insures uniform pressure, prevents distortion of electrode jacket. Automatic slipping with furnace in full operation replaces production-slowing methods used in less efficient designs.

Gas-tight passage of movable electrodes through roof forms an effective seal, free from friction. All valuable furnace gas is recovered for reuse. Roof lifting gear allows constant check of interior furnace conditions.

Lectromelt engineers welcome inquiries regarding your furnace requirements. Contact Lectromelt Furnace Division, McGraw-Edison Company, 310 32nd Street, Pittsburgh 30, Pennsylvania.

*Reg. TM U.S. Pat. Off.



Recent Developments in Slabbing Mills

by H. J. KALBERKAMP,
Chief Engineer,
Mesta Machine Co.,
Pittsburgh, Pa.

. . . . when maximum production is required the universal slabbing mill can best meet such needs . . . . for slabs up to 60-in. wide, the high lift, two-high mill is simpler, more economical, easier to maintain and more flexible . . . . the high lift mill does not have the capacity of the universal mill . . . .

As part of the large expansion in the steel industry over the last several years, a number of primary rolling mills have been completed and several such mills are now under construction. A renewed interest in universal slabbing mills developed as maximum capacity was demanded from the mills intended for the production of slabs for strip and plate.

The general arrangement of the slabbing mill and related equipment is largely dictated by the shape and size of the available site, the location relative to the steelmaking facilities, the area where the slabs are to be delivered, and the tonnages to be produced. The importance of an adequate track arrangement may appear self-evident but nevertheless cannot be overemphasized. A modern mill may produce as much as 4000 tons of slabs per turn. This means that about 4700 tons of ingots must be brought to the soaking pits and about 700 tons of crops and scale must be taken away and, if the strip mill or plate mill is remotely located, 4000 tons of slabs must be moved in eight hours.

The tonnages produced by the slabbing mills at different plants vary over a wide range. Tonnage rates are dependent on such factors as availability of steel, size of ingots and particularly the thickness and width of slabs produced.

Figures 1, 2, and 3 serve to show the material flow of some modern slabbing Mill installations. The first two mills shown have been in production for approximately three and one-half years. During this time sufficient performance data have been obtained to evaluate the suitability of the equipment and its arrangement.

Figure 1 shows the general plan of a universal slabbing mill located ahead of an 80-in. hot strip mill. The soaking pits are arranged in a building in line with the slabbing mill. This plant was laid out for a new site and for maximum ultimate capacity. Two rope driven ingot buggies of the end dump, cam tilting type, deliver the ingots on edge to two ingot receiving tables from where the ingots are delivered to the mill approach table by means of a roller table mounted on a transfer car. After rolling, the slabs are scarfed in a four sided scarfer. Crops and scale are handled in an adjoining yard. The slabs are delivered either directly to the hot strip mill for rolling into strip without reheating, or delivered to the furnace charging table for reheating, or to either one of two slab yards by means of a tilting table and a piler car.

At this plant, considerable tonnages of strip have been rolled directly from slabs without reheating. The advantages of this method of rolling are obtained at the expense of more difficult scheduling; since in direct rolling, the soaking pits, the slabbing mill and the hot strip mill, and to some extent the steel producing plant are operated as one unit.

Another example of a modern plan for a slabbing mill is shown in Figure 2. This mill produces slabs primarily for a 96-in. hot strip mill and has rolled slabs up to about 80 in. wide. In this installation, the mill is located some distance from the strip mill. Here again the soaking pits are arranged in a building in line with the mill building. Soaking pits are of the island type with the ingot tracks on one side and the ingot buggy track on the control side of the pits. The ingots are conveyed by a single self-propelled, end dump, cam tilting type ingot buggy to the ingot receiving table. The scale is removed from pits in the mill aisle and the crops from a two compartment pit located in a yard alongside of the mill building. This mill is equipped with a scarfer for top and bottom scarfing. All of the product is delivered to a slab yard parallel to the mill building. From there the slabs are loaded on cars and delivered to the slab yard at the strip mill. The arrangement of a separate slab loading

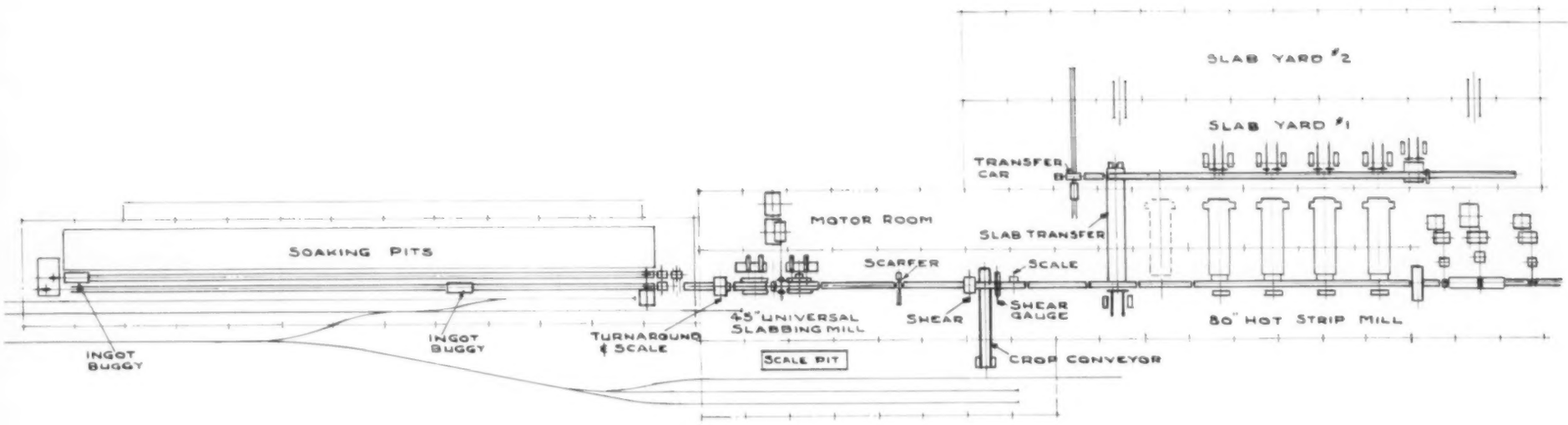


Figure 1 — Straight line flow features the arrangement on this 45-in. universal slabbing mill and 80-in. hot strip mill.

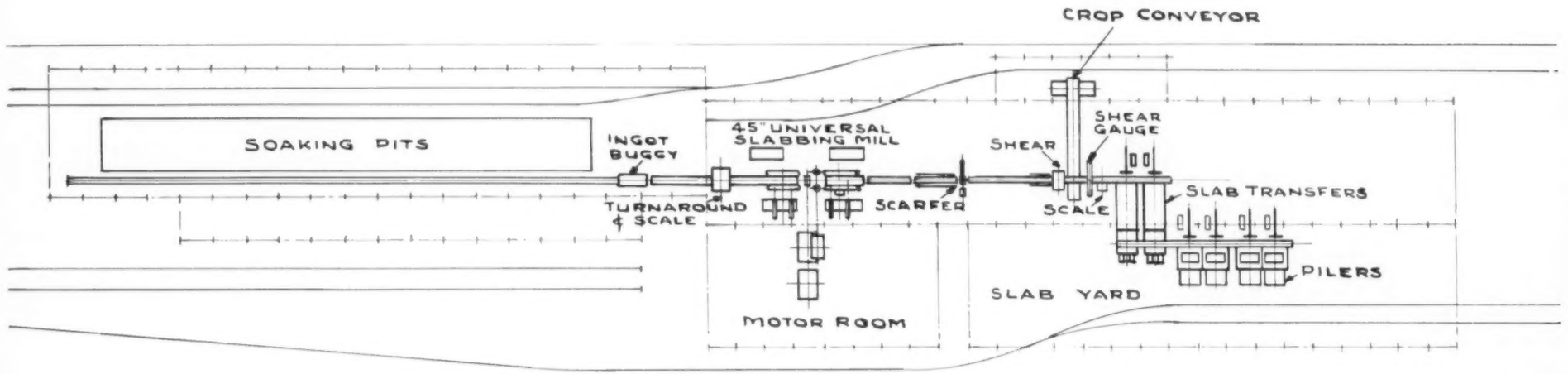


Figure 2 — This 45-in. universal slabbing mill produces slabs primarily for a 96-in. strip mill.

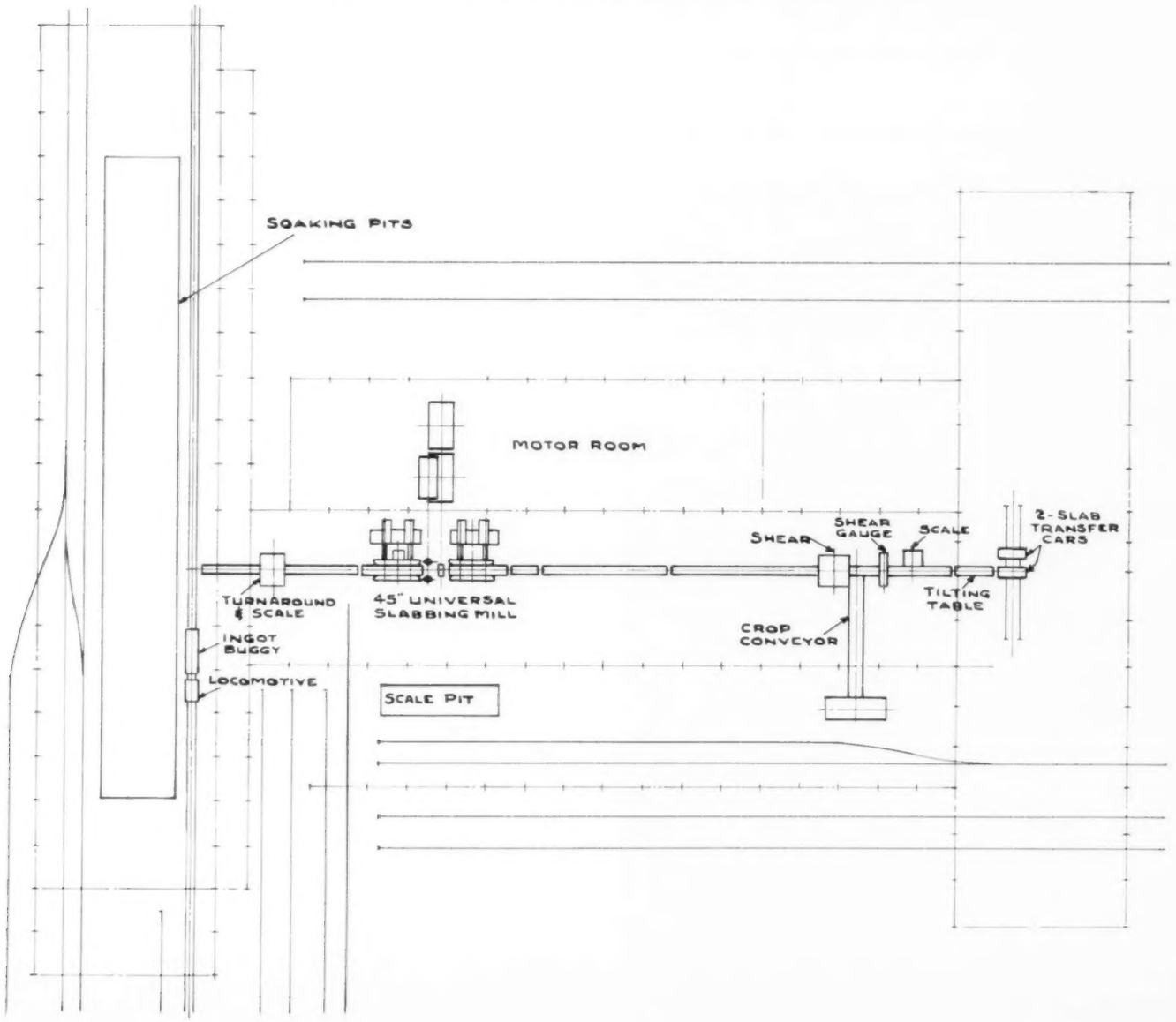
yard leaves the mill aisle entirely free for servicing the mill. The transfer arrangement also makes the ends of the slabs, after shearing, accessible for stamping.

A general plan of a mill completed late in 1957 is shown in Figure 3. This mill and two existing slabbing mills at this plant produce slabs for two hot strip mills and two plate mills. This slabbing mill is located some distance from the strip and plate mills. The pits are located in a building at right angles to the mill. The ingots are delivered to the mill by a motor driven side-dump type buggy. The buggy is hauled by an electric locomotive which also carries a generator for furnishing power to the pot tilting motor. The arrangement of the pits at right angles to the mill permits short ingot buggy runs and also readily allows the use of more than one buggy on the same ingot buggy track. The slabs are delivered to a cross aisle where they are loaded on cars for delivery to the strip and plate mill yards. Crops and scale are loaded in a yard parallel to the mill aisle.

On each of the layouts shown, a different type of ingot buggy was chosen to meet conditions at each plant. Each of the buggies in Figure 1 is connected to a rope drive at each end of the track. The drives are powered by 200-hp motors arranged with variable voltage control. Maximum speed of buggies is 1000 fpm. Collector systems are, of course, not required. However, control of a buggy is uncertain in case a rope breaks. The buggy shown with the arrangement in Figure 2 uses a motor and drive mounted on the buggy. This buggy is arranged also with variable voltage control. A collector system is required, but the buggy is under full control at all times. The ingot buggy used with the mill in Figure 3 is similar to other buggies at this plant. A man rides the locomotive and therefore the buggy is under full control. The buggy can also be used to bring ingots from another set of pits to this mill.

The three mills described above are equipped for turning and weighing the ingots on the approach side of the mill. On account of the increase in weight of the ingots over the last several years, it is more practical to do the turning of the ingots by separate means rather than on the ingot buggy, thus avoiding complications in the design of the buggy. Figure 4 shows an overhead type ingot turning device and scale. The advantage of

Figure 3 — This 45-in. universal slabbing mill has just been put into operation.



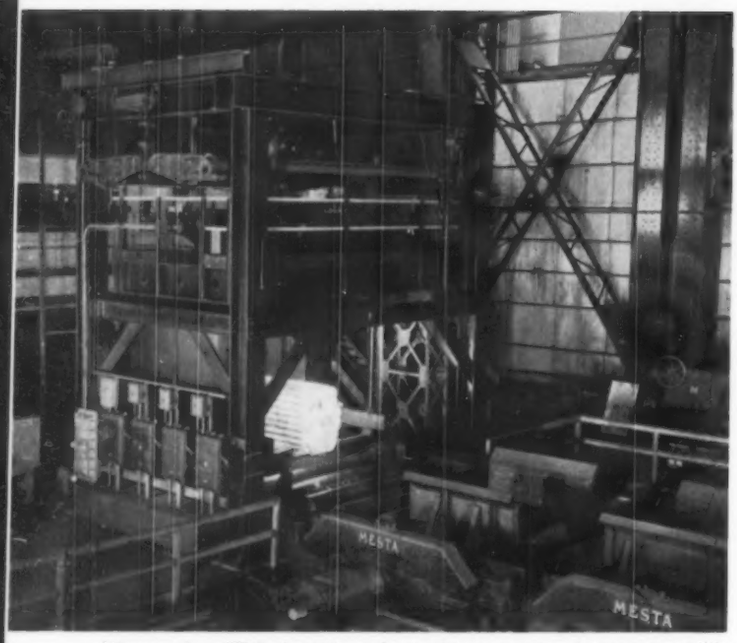
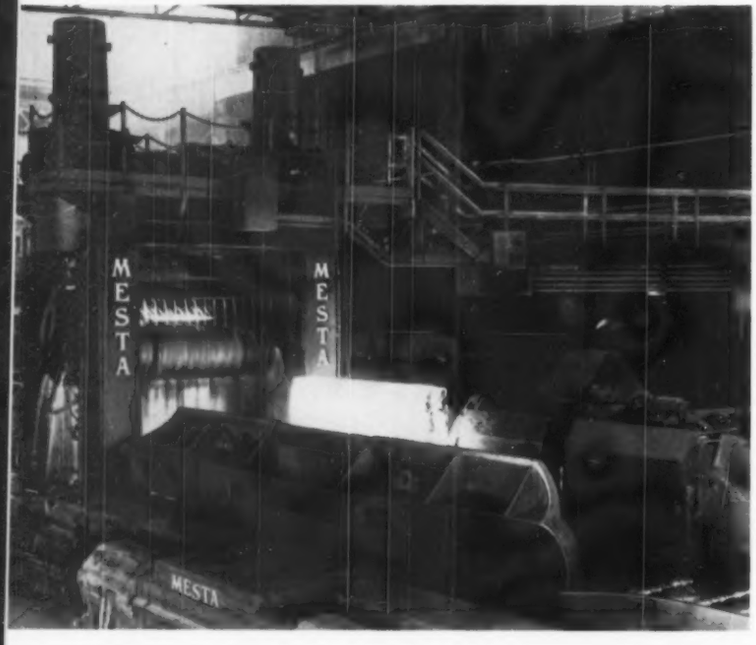


Figure 4 — This ingot scale and turnaround serves an 80-in. continuous hot strip mill.

rolling the ingots bottom end first is higher yield, mainly due to the fact that in shearing, minimum crop is taken off the bottom of the ingot first when cutting to specified length.

The mills installed in the above three layouts are of the universal type with nominal 45 x 90-in. horizontal rolls and 37 x 96-in. vertical rolls. The horizontal rolls have a maximum opening of 78 in. to permit taking the first few passes on edge for ingots up to about 78 in. wide. The horizontal rolls are each driven by two 3000-hp motors, making a total of 12,000 hp available for the horizontal rolls. The horizontal mills are arranged with high-speed screwdowns driven by two 200-hp motors with variable voltage control. The horizontal rolls are balanced by counterweights.

Figure 5 — Unit shown is a typical 46-in., two-high reversing, slabbing and blooming mill. Maintenance on these units is low and they are versatile.



The vertical rolls have a maximum opening of 90 in. and are driven by a 4000-hp, double-armature motor through fixed bevel gears and universal type spindles.

In addition to the layout shown in Figures 1, 2 and 3, several other installations have been recently built or are planned employing either a high-lift, 2-high or a universal type mill. The selection of the type of mill should be carefully made as either type has certain advantages. Serious consideration should be given to a high lift, 2-high mill unless the ultimate possible capacity is required or slabs over about 60 in. in width are to be produced.

A high-lift, 2-high mill with high-speed screwdown is well suited for producing slabs up to about 60 in. wide. This type of mill is much simpler than a universal mill and therefore lower in first cost, easier to maintain and affords greater visibility through the mill. Heavy edging passes may be taken as the full power on the mill is used for the edging passes. This permits reducing the number of different sizes of ingots to be provided by the steel works. This type of mill became very popular around the mid-thirties as the universal slabbing mill in use up to that time has many shortcomings. The high-lift, 2-high mill is the only choice if blooms, as well as slabs, must be produced. The universal mill is not suitable for the rolling of blooms since the shape of the bloom cannot be controlled and the sharp corners produced on this type of mill would make the bloom unsuitable for subsequent rolling. In passing, it may be stated that the mill shown in Figure 1 is used for breaking down ingots for delivery to a conventional blooming mill for rolling to final bloom size.

Figure 5 shows a typical high-lift, 2-high mill. This type of mill either as a single stand or in combination with a vertical mill has been developed to give satisfactory service and has become the workhorse of the industry. Maintenance is low considering the extreme service to which these mills are subjected.

Rolls for both types of mills are generally about 45 in. in diameter. The body lengths are up to 115 in. for mills without vertical rolls and up to 90 in. for universal mills. The 115 in. length of body for the high lift mill gives sufficient space for three edging passes and a bullhead for rolling slabs up to about 60 in. wide. The lift of the single stand mills is such as to give about 68-in. opening between the bullheads for rolling ingots on edge up to about 68 in. wide. Screwdown speeds are of the order of 600 in. per min. The screws are driven by two 200-hp motors with variable voltage control. The rolls may be driven through universal spindles by twin motors from 8000 to 12,000 hp at a base speed of 40 rpm. Rolls are mounted either in roller bearings or sleeve type bearings. The roller bearings have given good service but require more space than the sleeve type bearings and make it necessary that the feed rollers be mounted further away from the bottom roll. The top rolls are either hydraulically balanced or balanced by counterweights beneath the mill. The counterweights require less maintenance than the hydraulically balanced mills and make roll changing somewhat simpler.

Until about 25 years ago most mills intended for slab rolling were designed as mills of the universal type. The vertical rolls of these older mills are generally inadequately powered for substantial reductions due to

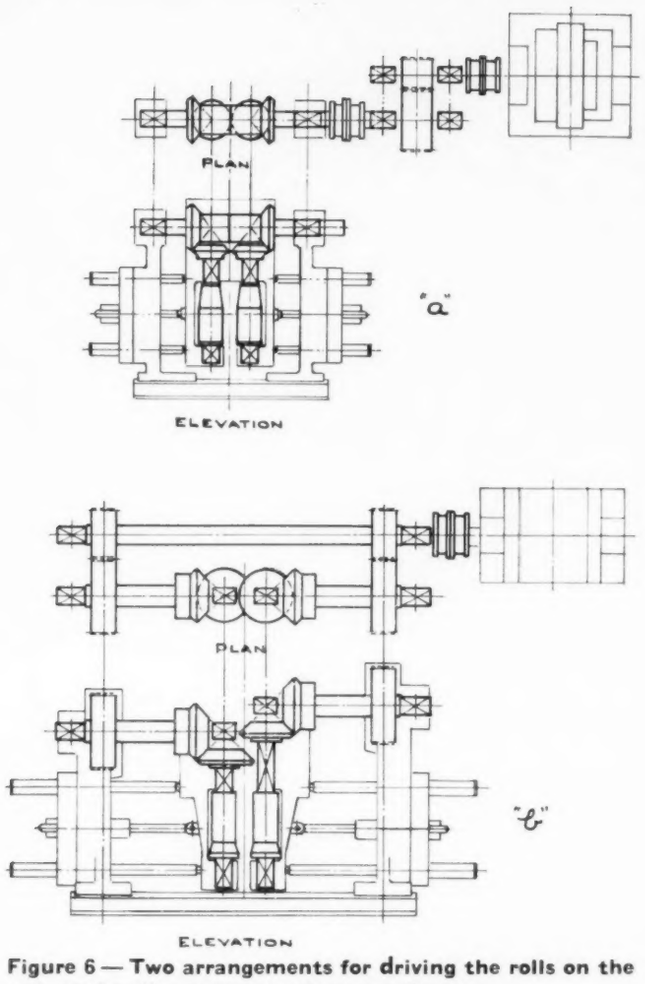


Figure 6 — Two arrangements for driving the rolls on the universal mill are given in these two figures.

limitations in the drive arrangement, the maintenance is high and the method of roll changing is awkward. Figure 6, a and b, shows diagrammatically, drive arrangements in use with these mills. The arrangement in Figure 6a shows the driven bevel gears mounted directly on the ends of the rolls, and the bevel pinions mounted on a splined or square shaft in such a manner that the pinions can slide on the shaft when the rolls are adjusted. The size of gears was definitely limited by the minimum centers of rolls required for producing the narrowest slabs for which the mill was designed. In order to permit the installation of somewhat larger bevel gears the arrangement shown in Figure 6b was developed. The driven bevel gears were staggered, thus providing more space for the gears. However, this made a more complicated drive arrangement and had the additional disadvantage that the rolls are not alike. The mounting of the bevel pinions is rather inadequate with either of these designs.

In order to change rolls it is necessary to disassemble and reassemble the drive. This is time consuming and ties up the crane over the mill for as long as a turn.

On account of the limitations of the universal mill available at the time the older mills were designed, the high lift, 2-high mill with high screwdown speed came into favor.

The vertical mill of modern universal mills is considerably improved over the older designs. Figure 7 shows diagrammatically the drive arrangement of a patented vertical mill recently developed. This design has the following features:

The driving bevel pinions are solidly mounted on the driving shaft which in turn is carried in roller bearings.

The driven bevel gears are of substantial size as the shafts upon which they are mounted may be spaced on average roll centers rather than on minimum roll centers.

The drive shafts, bearings and gears are enclosed in an oil-tight drive case.

Figure 7 — Sketch shows a more modern arrangement for driving the vertical rolls of a universal mill.

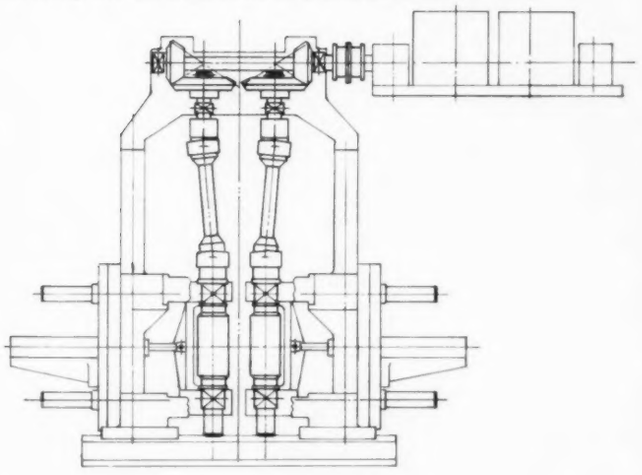
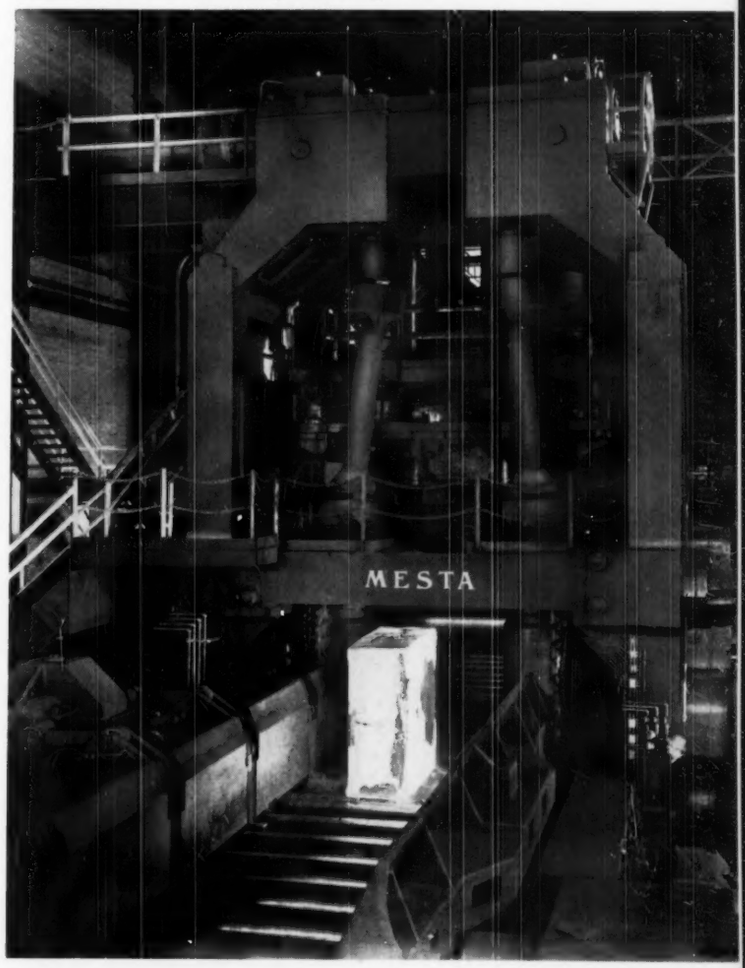


Figure 8 — A twenty-ton ingot is being rolled on the 45- x 90-in. universal reversing slabbing mill.



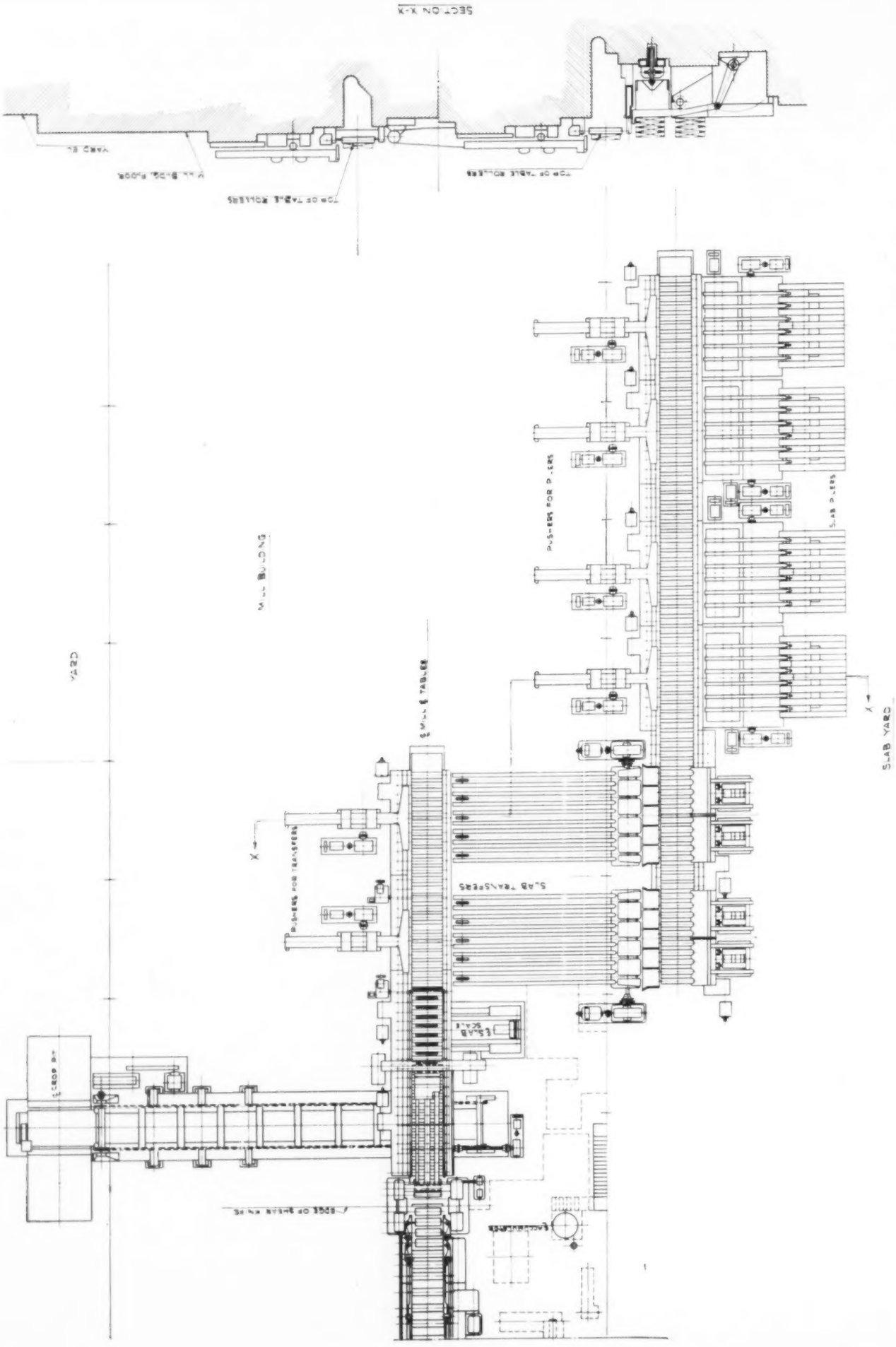


Figure 9 — It is very necessary to provide adequate means of disposing of the slabs produced on a high capacity mill.

The power is transmitted from the driven bevel gears to the rolls through universal spindles and removable couplings mounted on the rolls.

The rolls are symmetrical and therefore may be turned end for end for greater roll life.

The changing of the vertical rolls can be accomplished without dismantling any major part of the mill. By merely removing two spindle keeper plates, and moving the roll to the center of the mill by means of adjusting screws, the roll is lifted with a porter bar into the space between the spindles.

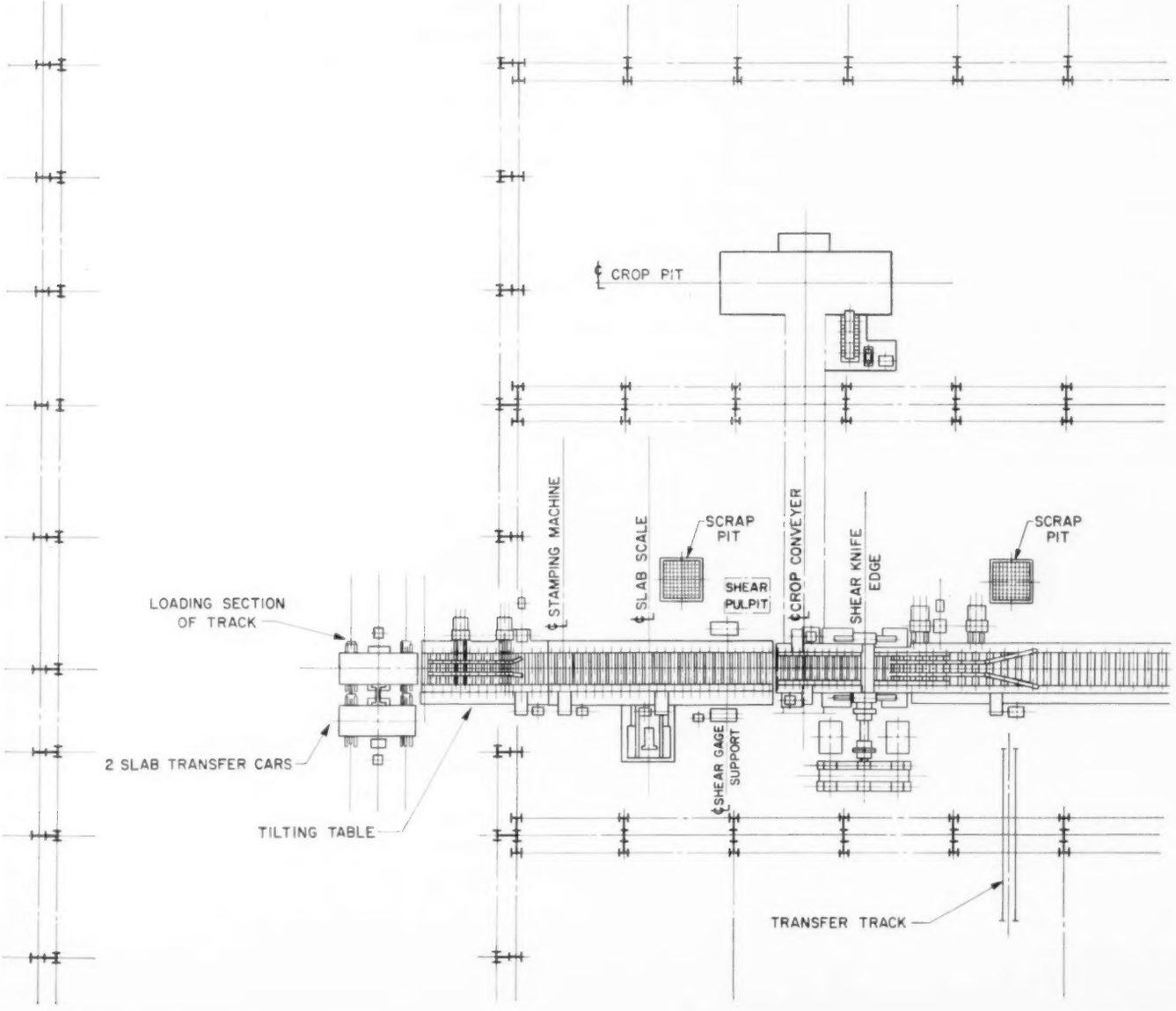
With a universal mill an edging pass is made at the same time as a horizontal pass, while with a high-lift mill separate edging passes must be made. Thus a universal mill requires fewer passes than a high-lift mill for the same reduction. For instance, compared to a seventeen pass schedule with six edging passes on a high-lift mill, only thirteen passes are needed in the universal mill. The extra distance traveled from the horizontal mill to the vertical mill and vice versa requires less time than the extra manipulation required with a high lift mill. Therefore, a modern universal mill has considerably greater production capacity than a high-lift mill rolling a similar product.

A universal mill is particularly suited for rolling slabs in the wider widths as the service on the front and rear mill tables and the manipulator is much less severe than on these units of a high-lift mill. Experience has shown that the front and rear mill tables and manipulators of a universal mill stand up remarkably well. Compared with these units of a high-lift mill the maintenance is considerably lower due to the less frequent and less severe manipulation of the ingots.

The front and rear tables and manipulators for either type of mill must be of very rugged design. The feed rollers of recent mills are directly connected to mill type motors and some of the mills now under construction extend this feature to the first several rollers on either side of the mill. It stands to reason that this trend will continue and the front and rear tables will soon have all the rollers driven directly by individual motors thus avoiding such high maintenance items as bevel gears and lineshafts.

There is no need here of going into the details of the

Figure 10 — This slab piling arrangement uses a tilting table to deliver the slabs to two slab cars.



electrical equipment used in connection with these mills as these have been fully covered previously in papers read before this society. Reference is made to "Electrical Design and Operation of a Modern 46-in. High Lift Slabbing-Blooming Mill" by George A. Kaufman and Andrew W. Smith, 1953 Proceedings AISE; "Electrical Features of the Universal Slabbing Mill at Fairless" by Warren Reid and R. H. Wright, 1955 Proceedings AISE; and "Electrical Features of the Great Lakes 45 x 90-in. Universal Slabbing Mill" by Harold C. Hoeft, 1955 Proceedings AISE.

The scale removal system of recent mills has received considerable attention. Provisions have been made for adequate scale flushing and for the handling of larger pieces by hoists suspended from trolleys running on overhead beams in the foundations below the tables and the mill.

In the latest mills the distance from the mill stand to the slab shear is made about 200 ft. This distance is sufficient for the installation of a scarfer and permits scarfing without interference with the operation of the mill or the shear for normal lengths of slabs. Over the last few years and particularly since the four-sided scarfer was developed into a satisfactory unit, the installation of a scarfer has been the subject of considerable study at various plants. A scarfer is definitely desired in mills arranged for direct rolling of strip from slabs.

The economics of scarfing are currently of great interest to engineers and operators. It is suggested that this subject be dealt with in a separate paper.

The shears of the mills shown in Figures 1 and 2 are of the hydraulic upcut type with the top knife adjustable for various slab thicknesses. The shears are of 2500 to 2800-ton capacity and have a 26-in. stroke. The hydraulic system consists of three quintuplet vertical plunger pumps, an air loaded accumulator and associated valves and piping.

The shear now being built for the mill shown in Figure 3 is of the downcut, motor driven mechanical type. This shear is designed for a maximum section of 900 sq in. and a maximum slab thickness of 12 in. The shear is of the start and stop type without clutch and has a 16-in. stroke. The shear is driven by two 1000-hp motors with variable voltage control. This shear requires a depressing table with receding section.

Rather extensive studies have been made regarding various types of shears, such as up-cut shears, down-cut shears, and shears with two movable knives. Each type has its advantages. The experience with various designs indicates that a down-cut shear is best, at least for heavy shears used with slabbing mills. This design makes the simplest type of shear and gives best support for the slab during the shearing operation.

The three mills described are equipped with crop conveyors. This is considered the best method of handling the crops from high capacity mills although other means, such as skip hoists, have been used.

It is equally important to provide adequate means of disposing of the slabs produced on the high capacity mill as it is to bring the necessary number of ingots to the mill. Figure 9 shows in a larger scale the slab piling arrangement used with the mill shown in Figure 2. Four pilers have been provided, each with a pile drag-off arrangement, thus providing space for eight piles. This gives considerable flexibility in the operation of the cranes and also permits segregation of different grades of steel or different cuts from the ingots.

Figure 10 shows a slab piling arrangement requiring less equipment and still providing adequate slab piling capacity. This arrangement uses a tilting table delivering the slabs to two slab cars, each of which has space for two piles of slabs.

This paper shows some of the more important slabbing mill features developed up to the present. To meet the requirement of the steel industry, further developments will no doubt be made in this field in the future.

Discussion

PRESENTED BY

T. J. KOENIG, Division Superintendent—Rolling, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

E. C. PETERSON, Vice President, Rolling Mill Equipment Div., Birdsboro Steel Foundry and Machine Co., Birdsboro, Pa.

H. J. KALBERKAMP, Chief Engineer, Mesta Machine Co., Pittsburgh, Pa.

T. J. Koenig: The paper as given by Mr. Kalberkamp was fairly complete. There are, however, a few items he makes reference to, when talking of the tons per turn, that should receive a little more detailed discussion. Four thousand tons of slabs, per turn, entails good delivery from the soaking pits, plus adequate cleaning facilities, for ingot buggy tracks and mill flumes. It also means that to maintain these averages, good and sufficient crop handling facilities must be developed.

The scale flumes that have been designed today are questionable as to whether they will handle 4000 tons of slabs per turn for 20 consecutive turns, due to the amount of ingot debris that falls through the table lines, other than scale. The safe handling of this debris is really the item in question.

Reference is made to the amount of crops that must also be handled. This again can become a serious bottleneck when rolling 4000 tons of product steel in eight hours and for 20 consecutive turns. The facilities should be simple and as maintenance-free as the design will make possible.

Mention is made of the three methods of delivering steel from the pits to the mill; two of which are now in use, the third of which is in design. The speed of the cable-drawn buggy is mentioned and even at certain times these buggies are not adequate in keeping the mill supplied with steel. The reasons for this are the distances which have to be traveled and the necessary slowdown and automatic stops needed to insure safe operation. The question that comes to mind is the speed at which the collector system type of buggy can be driven and with the buggies in constant use, whether it is possible to keep the ingot buggy tracks clear of debris without endangering personnel or equipment.

The next item to receive consideration is the comparison of mechanical counterweight, versus the hydraulic counterweight. True, the mechanical counterweight requires less maintenance than the hydraulic, but with the hydraulic counterweight it is possible to have a more accurate balance than with the mechanical counterweight. Would you please discuss the advantage

and disadvantage of each? The vertical mill drive as shown in Figure 7 is superior to the drives shown in Figure 6.

The type of shear is important, depending upon the type of product to be rolled. The down-cut or the up-cut shear distorts one end of the slab and this can become very serious on rolling light gage steel, so much so that some other means of flattening this product must be used. It is agreed that the down-cut shear will have less distortion than the up-cut shear. The method of disposing of rolling product is far more flexible in Figure 9 than it is in Figure 10, both of which can be made adequate to handle the 4000 tons of product being rolled per turn.

E. C. Peterson: Referring to the ingot weighing and turning device, I would like to inquire whether or not his company has applied any of the so-called load cell weighing devices to this kind of unit, as compared with a conventional beam scale, and if so, with what results?

I would also like to ask how the universal mill would apply where high alloy and especially stainless steels are being rolled. We notice that when stainless steels are being rolled, edge work is very desirable, and, with a high-lift mill, the edge of the slab fits into a groove in the roll which keeps it from getting sharp corners. With a universal mill, edging is done on a plain roll, producing sharp corners on the slab. This corner might invite cracking. Possibly Mr. Kalberkamp's firm has had some experience in this matter and, if so, it would be enlightening to hear about it.

H. J. Kalberkamp: Mr. Koenig's remarks are well taken. I purposely used the high production rate of 4000 tons per turn to emphasize the importance of the material handling problem connected with a mill of the type described.

It appears that further improvements are needed in the method of removing the large amount of scale for high tonnage mills. Concerning the scale at the ingot buggy track, a method has been used on one of the mills that we built where the floor between and adjacent to the buggy rails was made in the form of an open grid. This arrangement permits scale to fall through to the floor of the soaking pit basement from where it is removed by a motor-driven scoop depositing the scale in the scale flume under the ingot receiving table.

With respect to the counterbalancing of the mill, we prefer the counterweight type mill as it is simpler in design, easier to maintain and, if properly designed, quite satisfactory.

Regarding the type of shear, experience with various types of shears has convinced us that the straight forward down-cut type is the best shear for heavy slabbing mill installations.

In answer to Mr. Peterson's questions, cell type scales have been used in connection with the ingot turnaround and scale. The cell type scale has lately become fairly popular.

As far as rolling alloy steels on a universal mill is concerned, considerable tonnages have been rolled on this type of mill at plants where large tonnages of carbon steels as well as alloy steel are produced and thus a high tonnage universal mill is justified. In order to avoid sharp corners on the slab, the edging mill is not used at the last or the two last passes.

At plants where alloy steels only are produced, the tonnage is not sufficient to justify a high production mill.

Scarfing is done with the high lift mills quite extensively and the ragging of the rolls has no particular detrimental effects. ▲

Revised and rearranged collection of articles which appeared in the Iron and Steel Engineer between 1943 and 1950 . . . a book for rolling mill men and for anyone interested in rolling mills and roll design . . . written from a practical viewpoint by one who has had considerable experience in the art of roll design.

ROLL DESIGN and MILL LAYOUT

By **ROSS E. BEYNON**

Cloth bound . . .

128 pages . . .

303 illustrations . . .

Price: To AISE Members . . . $3.00
To Others $5.00

ASSOCIATION OF IRON AND STEEL ENGINEERS

1010 Empire Building **Pittsburgh 22, Pa.**

Good methods, planning, coordination, and adequate safety precautions are essential for blast furnace rebuilding jobs . . . . success depends on complete cooperation and enthusiasm of all the personnel concerned.

Techniques

Figure 1 — The view of Sparrows Point's "J" blast furnace shows gas system auxiliaries in the foreground.

IN the past one hundred years there has been little change in the process of making pig iron. Iron ore, coke and limestone are fed into a blast furnace and descend through a vertical stack, meeting ascending gases rich in carbon monoxide. The iron ore is reduced to metallic iron and tapped out of the lower part of the hearth. Lime from the limestone combines with the nonmetallic elements of the ore and coke to form slag which is also removed from the hearth.

During this same one hundred years, there has been much development and improvement in the design of the blast furnace (Figure 1). Today, the large modern blast furnace is a complex and precise apparatus. The major sections of the furnace itself are the stack, bosh and hearth (Figure 2). The raw materials are carried up the skip automatically and dumped into a hopper which is designed to allow charging without the escape of furnace gases. Blast air is compressed by either a turboblower, steam or gas engines and piped to the hot stoves where it is heated before entry to the furnace at the upper portion of the hearth. Furnace gases pass up the furnace stack to the bleeders and downcomers, which lead to the dust catcher, gas washer and other gas cleaning equipment.

Every four to five years a blast furnace is taken out of operation for the replacement of stack lining and certain repairs on the furnace equipment; every eight to ten years a furnace is blown out for removal and replacement of the refractory lining of the furnace stack, bosh and hearth as well as a complete rehabilitation of the furnace auxiliaries.

Several papers describing the rebuilding of blast furnaces have been presented to the AISE. This paper will concern itself with the techniques, innovations and methods used on all blast furnace rebuilds at the Sparrows Point plant of Bethlehem Steel Co. Sparrows Point's procedures have been developed over many years and may well prove adaptable either in part or in total to rebuilds in other plants.

PLANNING

Pig iron requirements of a modern integrated steel plant dictate that rebuilds be accomplished with a minimum downtime. Detailed planning, development of efficient methods and thorough co-ordination are required to bring all phases of the job to concurrent completion.

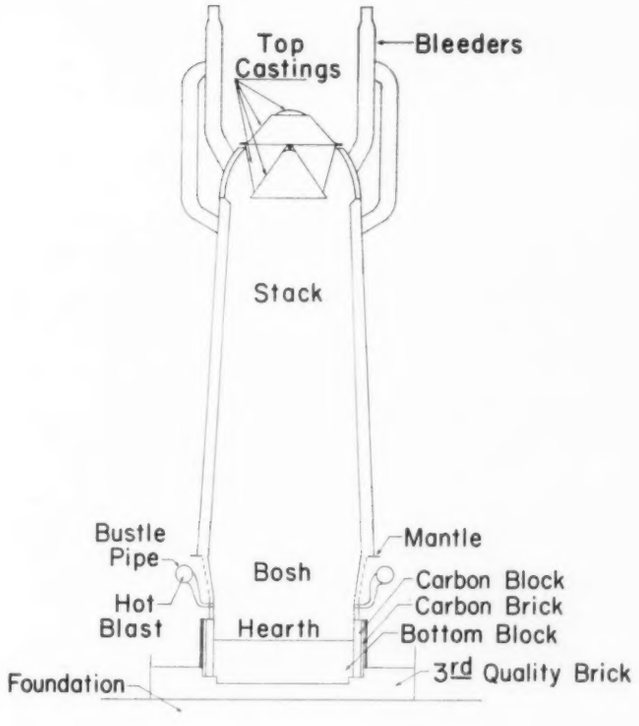
At the Sparrows Point plant, blast furnace rebuilding is done under the direction of the central mechanical department, with the assistance of the blast furnace, electrical and engineering departments. Planning and supervision of the job are done by mechanical department personnel.

The removal and replacement of the refractory lining

by C. F. BESSENT, Supervisor of Maintenance, Mechanical Maintenance Dept.,
Bethlehem Steel Co., Sparrows Point, Md.

In Rebuilding A Blast Furnace

Figure 2 — The major sections and operating parts of a blast furnace are shown on the diagram at right.



of the furnace proper is the phase of the job which determines the length of time that the furnace will be out of operation. While the relining takes place, as many as a hundred other major jobs may be accomplished, and all must be completed before the furnace is returned to operation.

During the planning stages of a blast furnace rebuild, personnel of the engineering, blast furnace, electrical and mechanical departments compile a list of needed repairs and alterations, shop fabrications are built and materials are accumulated for the job. Considerable attention must be given to area layout in the vicinity of the furnace so that roadways, material storage areas, hoisting machinery locations and field shops may be placed near the job without interference.

PREPARATIONS

As the starting time for the rebuilding approaches, preparatory work must be done. Temporary air, oxygen and water lines are installed, tools and equipment are stored on the job site and material-handling equipment is erected where possible. Bricklayers precut hearth-bottom blocks, bottoms of tuyere bowls and piers between bosh coolers so that time may be saved during the actual relining. Carbon-hearth blocks are set up and numbered so that they will fit properly on installation.

The new hearth jacket, tuyere jacket and bosh bands are erected, checked and disassembled. The bell and hopper are checked for proper fit. Hoisting engines for furnace top handling are anchored in place and fitted with the required cables. Thorough examinations are made of the skip bridge and stock trestle so that proper structural shapes may be on the job site when needed. Railroad crews are brought in to recondition tracks be-

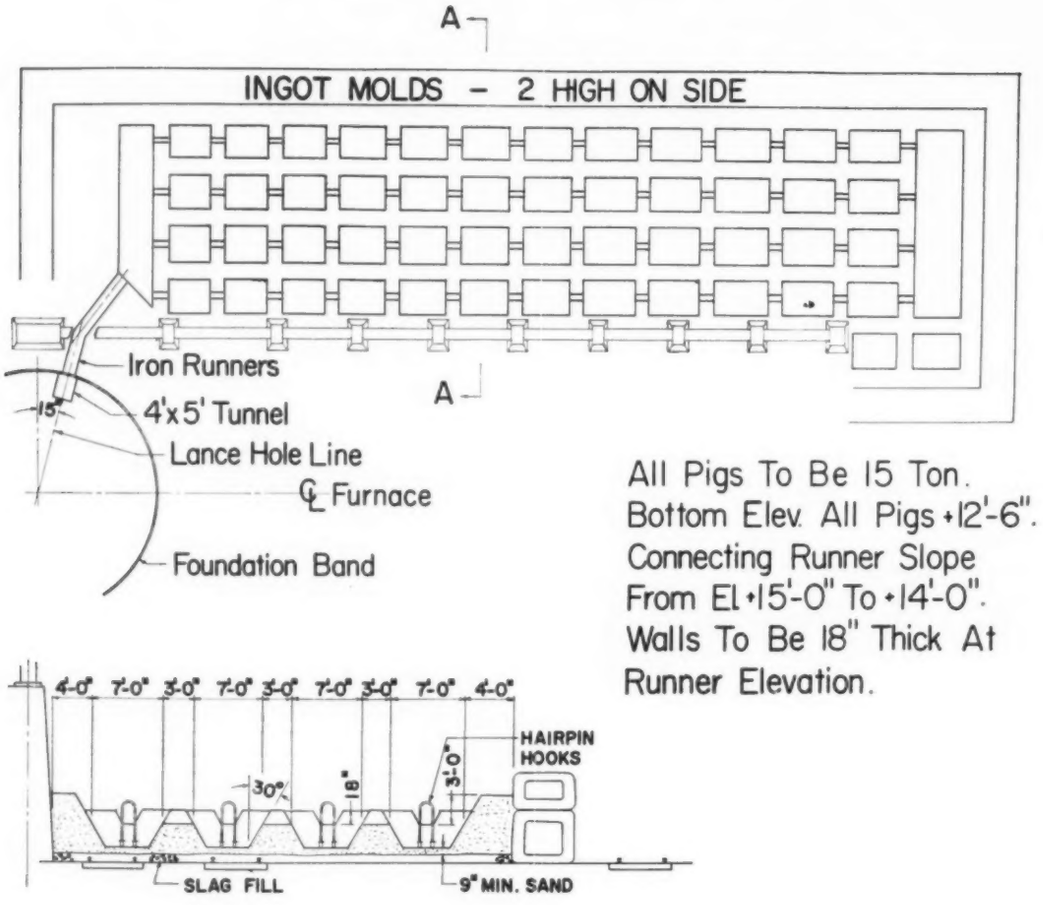


Figure 3 — This diagram shows the general layout of the sand bed into which the furnace salamander is tapped.

fore the furnace is taken down, so that tracks will not be out of service during the repair.

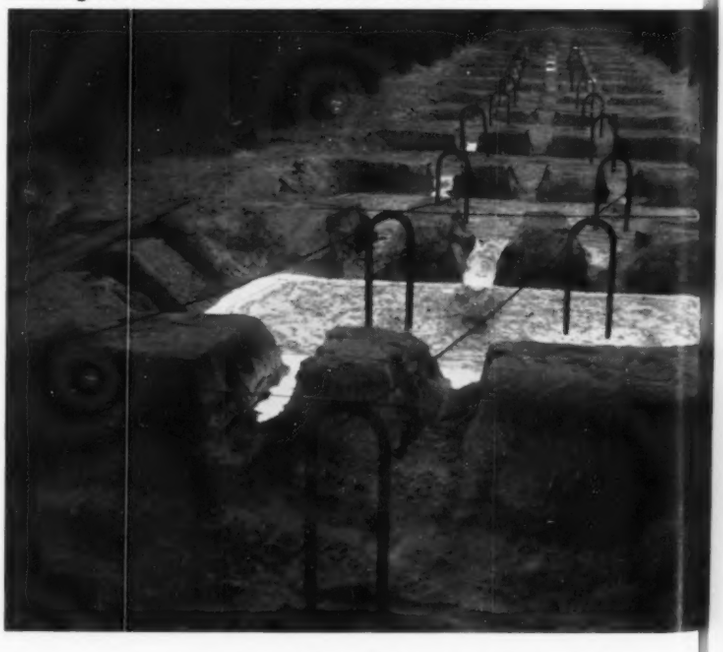
SALAMANDER TAP

The metal in the hearth bottom, below the tap hole level, which cannot be drained off while the furnace is in blast, is called the furnace salamander.

A short time before the blast furnace is taken out of production, final preparations are made for tapping the salamander. A 4-ft square section of the foundation band is removed and a tunnel is dug into the third quality brickwork for a distance of about three feet. In this tunnel, three holes are drilled 36 in. into the third quality brick, each with a different slope and at an angle which is directed into the center of the furnace, at the bottom of the salamander, which is determined by past experience and records. When the furnace is shut down, an oxygen lancing operation is used to tap the salamander starting with the hole with the least slope. The least slope used is $\frac{1}{2}$ in. to 1 ft.

A salamander bed (Figure 3) is laid out and the bed made shortly after the last cast of the furnace. Damaged ingot molds are used as the boundary of the bed. Crushed slag is used as a base for the sand bed. At least 12 in. of sand is maintained under the molten iron. Sumps are dug outside the bed to provide water drainage from the bed and 6-in. vent pipes are installed at 20-ft centers along the sides of the bed to bleed off any gas or steam formed under the bed as the molten iron fills it. The sand is formed into molds, each of which will hold approximately 15 tons of iron. A sandblasted hairpin shaped hook is placed upright in each mold cavity to facilitate pig removal. Iron runners or a bricked

Figure 4 — The furnace salamander is shown as it starts to overflow into the next sand mold of the bed. The hairpin lifting hooks are tied together to prevent them from turning over from flotation or the iron flow.



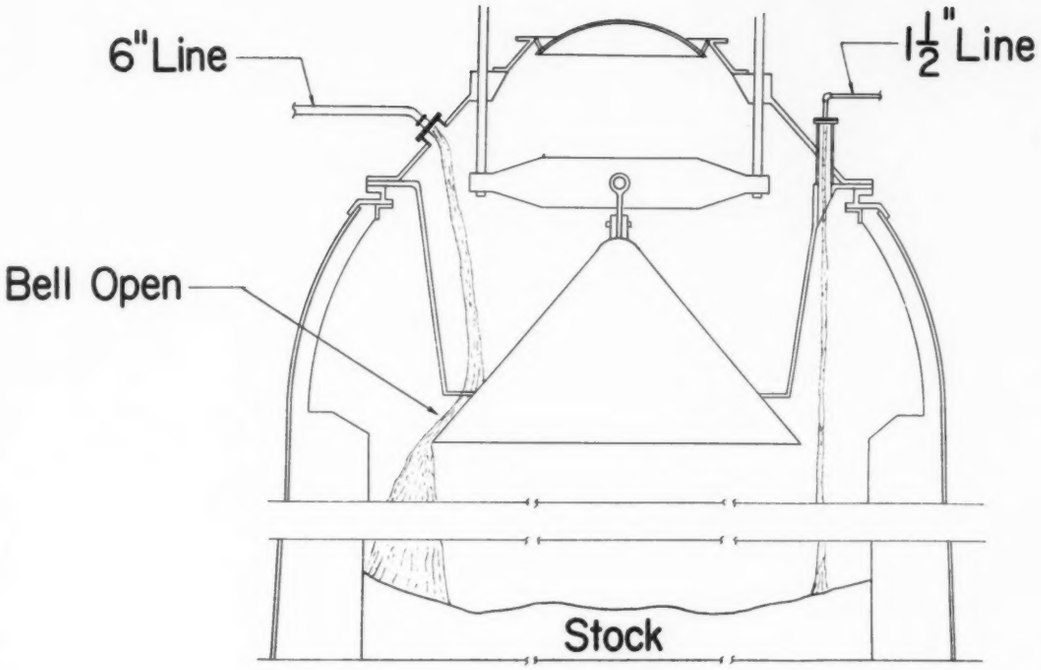


Figure 5 — The location and flow of flood-down water into the furnace top are shown in this diagram.

trough are set between the tapping hole and the first sand mold (Figure 4).

At Sparrows Point, blowing down the furnace to lower the stock level has been discontinued. The reasons for not blowing down are:

1. The furnace maintains maximum production until the last cast is made.
2. The need for special precautions to control top temperatures is eliminated.
3. The stock left in the furnace distributes water to the brick lining during flood-down.

After the last cast is made, wind is taken off the furnace, the blow-pipes are dropped and the tuyeres are plugged with clay. To insure against gas burning at the tuyeres during flood-down, the clay plugs are backed up with fabricated jack plugs or dummy blow-pipes. To prevent possible accidents, all gas and oxygen lines are shut down prior to flood-down. Cooling water is shut off to the hearth coolers in the vicinity of the salamander tap hole. All forces are removed from the furnace area when the salamander lancing is started and kept in the clear until the furnace has quieted after the beginning of flood-down.

FLOOD-DOWN

Immediately after the salamander tap has been completed, flood-down begins. Water is introduced to the furnace at the gas seal hood and measuring rod holes, flows over the open big bell and is distributed through the stock in the furnace (Figure 5). Some 2500 gpm are made available for flood-down from the gas washer spray pump (2000 gpm) and an auxiliary booster pump (500 gpm). Although large volumes of water are available, control of flooding must be maintained until burning gases at the bosh become harmless to the furnace columns and structure. After this initial explosive hazard has passed and the furnace "quiets down," full volumes of water are kept running for six or more turns. The time required for tear-down is greatly reduced by extensive flood-down.

The first job to be done after the furnace "quiets down" is the cleaning of the top and all circle platforms. The furnace area is roped off, safety men are posted, and all material is thrown over the side to the ground. After this cleaning and still during flood-down, four or more 3 x 4-ft access holes are cut in the stack shell at different elevations. These access holes are used by forces entering the stack during "tear-down" and relining (Figure 6).

In order to remove stock and rubble from the furnace,

Figure 6 — Stack access hole is shown from outside of the shell with the brick lining remaining in the stack.

Figure 7 — The furnace stock, brick rubble and bosh lining are seen through the tuyere jacket rake-out hole. The horizontal plate at the bottom of the opening serves to protect the hearth cooler piping from damage during the clean-out operation.

two large sections of the tuyere jacket are removed (Figure 7) and the tuyere lining is cut through. High pressure hoses are used to start and maintain flow of stock out of these rake-out holes (Figure 8). Excavator front-end loaders on tracks (Figure 9) remove debris from rake-out holes and dump it onto chutes which empty over the side and into 10 wheel or rock body dump trucks of 15-ton capacity.

TOP MECHANISM REMOVAL

Top castings are removed from the furnace after about three turns of flooding-down, but flooding is continued during their removal. In order to save time in rigging, any shutdowns of the furnace during the last week of operation are used to hang necessary rigging, or if there is no shutdown, riggers wear approved gas masks to accomplish their preparatory work. Lifting beams are kept on hand for each casting to minimize lashing and tying requirements.

Figure 8 — The flow of furnace stock out of the rake-out holes in the tuyere jacket is started with high-pressure water hoses.

Work on the furnace top during flood-down is often slowed by steam. If steam does pose a problem, gas torches inserted into stack access holes are used to raise the vapor temperatures and eliminate the steam (Figure 10).

While stock is being removed through the tuyere rake-out holes and top castings are being removed, iron runners at the iron notch are pulled and excavation is started for entry to the hearth through the hearth jacket at the furnace front. A ramp is dug from casthouse floor elevation to the bottom of the hearth jacket, using a $^{3}/_{4}$-yard backhoe (Figure 11). The debris removed by the backhoe is loaded into dump trucks which drive up onto the casthouse floor by means of a temporary earth ramp at the front of the casthouse (Figure 12).

As soon as the hearth jacket is exposed at the furnace front, it is burned free and removed. By means of blasting, lancing and use of the backhoe and front-end overhead loader, access to the furnace hearth is gained at the front, thus allowing stock and rubble removal through three openings; one in the hearth jacket and two in the tuyere jacket. All stock and rubble is worked out by the mechanical equipment.

After removal of top castings, the working scaffold is lowered into the furnace for use by tear-down labor. Watering is stopped at this time. Before tear-down begins, steel safety screens (Figure 13) are installed in each bleeder offtake to protect men working on the scaffold from debris which might be dropped when bleeder and off-take repairs are made.

STACK LINING REMOVAL

The working scaffold is raised and lowered on four hoists mounted on a hoist frame which rests on and is bolted to the tunnel-head casting. The scaffold diameter is varied as needed by the use of telescoping arms (Figure 14).

Working from the above described scaffold, laborers use pneumatic tools and hand tools to loosen the wear irons and brick lining, which are dropped into the hearth and removed through the previously mentioned holes in the hearth and tuyere jacket. Air for pneumatic tools is supplied to the scaffold by a 3-in. hose from the tunnel-head to a manifold on the scaffold. Stack coolers are pulled from the outside ahead of the stack cutting and the cooler holes are blocked with kidney-shaped wooden blocks, which prevent tool points from being driven through the holes (Figure 15).

While stack cutting is in progress, it is most important to remove all rubble from the furnace promptly, or the scaffold will come to rest on the rubble and cutting must be stopped until the debris is removed.

In addition to laborers, a shell inspector also rides the scaffold during tear-down. If cracks or opened joints are discovered in the shell, staging brackets are welded to the shell at the defect, so that a tight scaffold may be erected and the shell repair made while other work continues at a lower level.

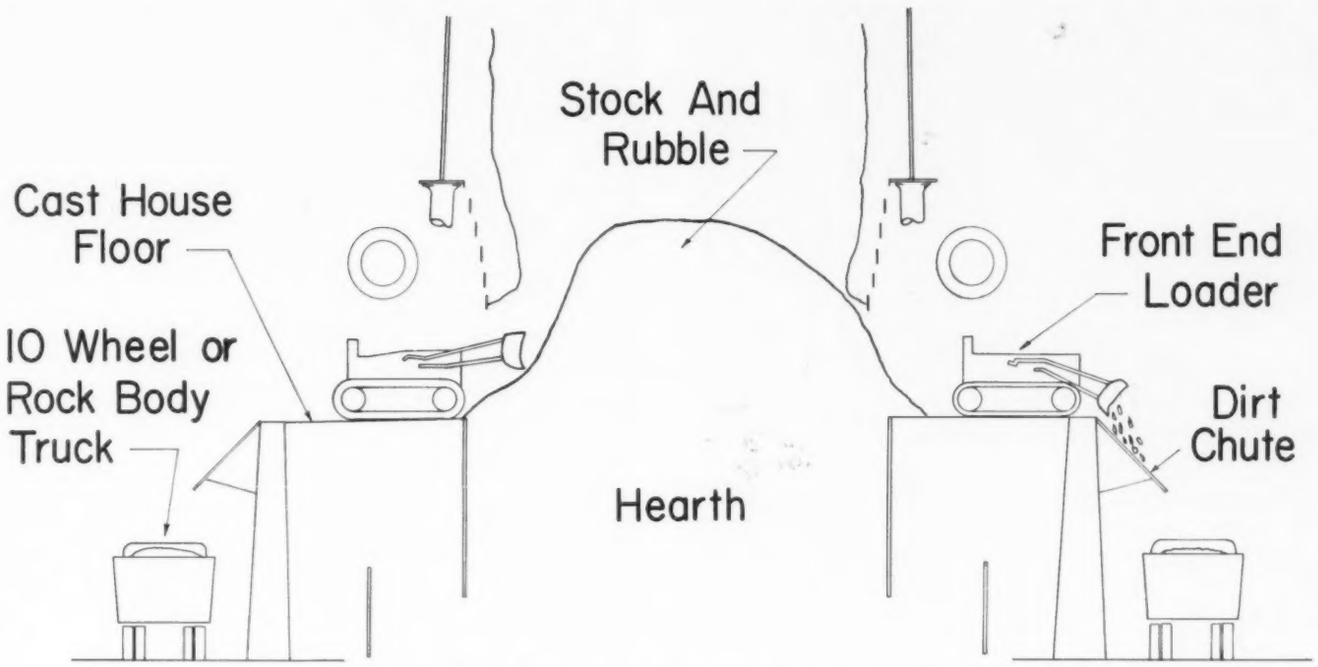


Figure 9 — The removal of rubble from the furnace tuyere rake-out holes and loading of transporting dumps is shown in the diagram.

After the stack lining is removed, the mantle is scaled and inspected. If no further work is to be done from the swinging scaffold, it is raised to the top of the stack and kept there until needed for use in rebricking the stack.

If it is necessary to replace bosh bands and tuyere jacket during the rebuild, they are scraped out while the stack lining is being removed.

BOSH AND HEARTH REMOVAL

Blasting with light charges has proved effective in knocking down tuyere and bosh walls. Debris from the tuyere and bosh walls is removed by the excavator front-end loaders, backhoe, front end overhead loaders and bulldozers.

If structural alterations to the mantle are required,

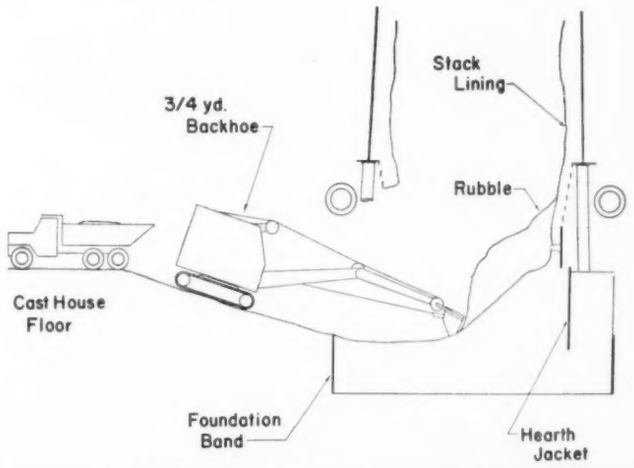
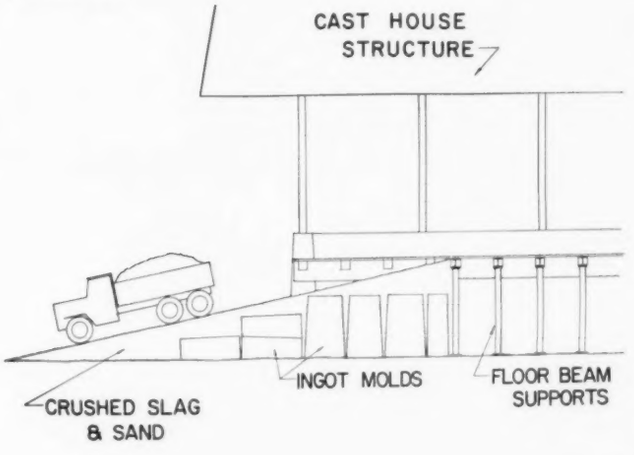


Figure 11 — The removal of the hearth steel and floor at the front of the furnace permits the utilization of 3/4-yard backhoe to remove stock and rubble from the hearth.

Figure 10 — Open-flame gas torches at the stack-access holes above the stock line eliminate any steam condition inside the stack.

Figure 12 — An earth-fill ramp allows rubble-removing trucks to load at the furnace with a minimum of handling of material.



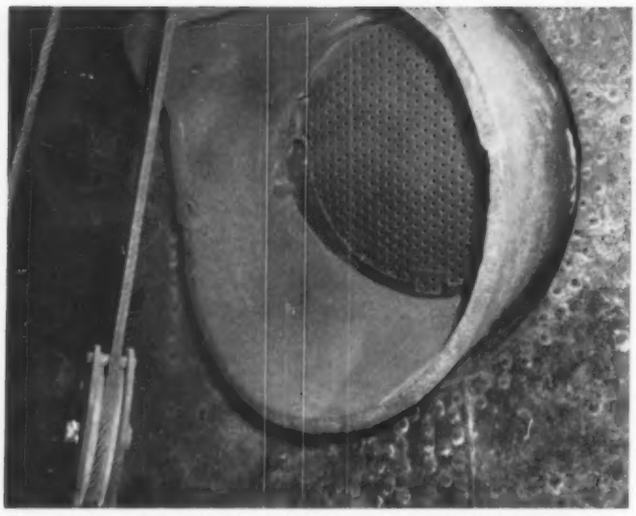
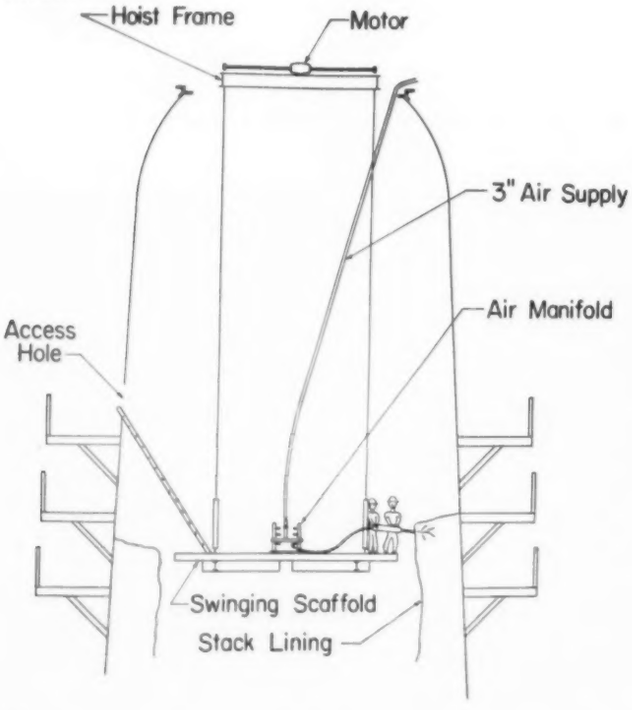


Figure 13 — Special plate bulkheads, installed in the furnace bleeder off-takes, protect workmen in the stack and hearth from material and debris falling during bleeder work.

a scaffold is erected (Figure 16) at the mantle elevation and made tight so that work may continue below the scaffold. Erection of the mantle alteration scaffold is done during lunch periods to avoid interfering with laborers in the hearth.

Cutting in the hearth continues until a satisfactory surface for rebricking is reached. Rubble is removed through the furnace front (Figure 17) and also by conveyor through a tunnel dug at the salamander tap hole. Usually, all bottom brick must be removed and, in some cases, cutting must be continued to the concrete foundation. If, in tapping the salamander, all of the iron was not drained from the bottom, the remaining salamander must, of course, be removed before rebricking begins.

Figure 14 — A scaffold suspended from a hoist frame on the tunnel head provides a work platform for stack lining removal.



There are several usable methods for removing any solidified metal remaining in the furnace bottom. There is, however, only one sure time-tested method. The edges of the salamander are located and all brick is cut away from the sides of the iron mass. Holes are lanced at 3-ft centers into and three-fourths of the way through the salamander. Without cooling, the holes are loaded with an ammonium nitrate-type blasting agent and blasted. In most cases, blasting in this manner will crack the iron mass into pieces which may be rigged out of the hearth, but in cases of particularly extensive salamanders, it becomes necessary to resort to dynamiting.

In blasting iron with dynamite, it is essential to cool the mass before loading the holes. Cooling is accomplished by damming the hearth and running water into the holes and over the salamander, until the mass is sufficiently cooled. A period of approximately 12 hours is usually required for necessary cooling.

After removing the salamander, cutting in the hearth is resumed until a satisfactory foundation is reached. The old stave coolers are then pulled into the hearth, removed and the hearth jacket is scaled.

As soon as it can be determined that there will be no further use of explosives in the hearth, the new bosh bands may be hung. As was previously stated, the bosh bands were drilled, assembled, matchmarked and disassembled before the furnace was taken down. In disassembling the bands, they are split into only two sections, each of which comprises ½ of the entire basket. The sections are rigged into the furnace (Figure 18), alined and secured in their final position.

The brickhandling system (Figure 19) for supplying the relining of the stack may be installed as soon as the bosh bands are secured. During lunch periods, a tight scaffold is constructed on the third bosh band from the mantle. Access to this scaffold is provided from the outside brickhandling platform by removing a short section of bosh band and placing roller lines through the opening in the bands. The safety scaffold is installed 13 feet above the tight scaffold and rests on corbels bricked out from the stack lining. The function of the safety scaffold is the protection of men working on the tight scaffold.

Figure 15 — With stack coolers removed before the lining is cut out, special wooden block plugs are necessary in the open cooler holes to prevent tool points from being driven out through cooler holes.

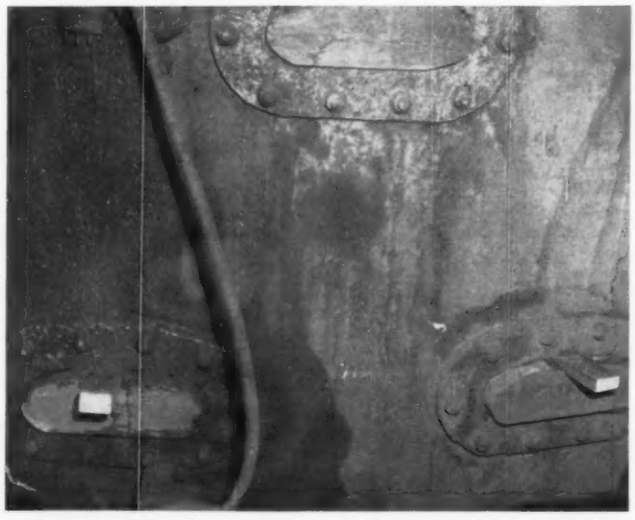


Figure 16 — A staging supported by beams hanging from the tuyere stock hanger brackets permits work on the mantle to progress without interference with the digging in the hearth below.

Bricklayers in the stack work from the swinging scaffold which is brought down and reoutfitted as soon as the tight scaffold has been completed. Brick for the stack is taken up to the swinging scaffold in steel mesh slings by two 2500-lb, 300-fpm hoists located on the tunnel-head and operated from the swinging scaffold by pushbutton pendant controls.

Brick for the stack are brought by lift truck to elevators on a temporary brick-handling platform located outside the casthouse and adjacent to the furnace. The elevators raise the pallets to the top deck of the brick platform, where they are removed by another lift truck. On the top deck, the pallets are broken down and fed on the roller lines to the tight scaffold. On the tight scaffold, slings are loaded and hoisted to the swinging scaffold through holes in both the safety and swinging scaffolds. Communication between the several loading levels is furnished by the use of a buzzer and phone system. It is necessary that the accumulation of fallen brick bats and cuttings be cleaned off the safety and tight scaffolds during lunch periods. Throat wear irons are handled by the same system as stack brick.

A $\frac{7}{8}$-in. diameter wire rope serves as a sweep-center during stack relining. The cable is fastened to the tight scaffold at the center of the mantle and is secured at the top on the center of the tunnel-head ring. Unless extreme, any furnace tilt is taken in the stack, allowing the hearth and bosh to be laid plumb. Each course of stack brick is trammed as it is being laid. It is important that all bricklaying be done to a high degree of workmanship. Tight joints, level courses and staggered bonds are essential. At Sparrows Point, stack brick is cut to within one inch of the shell and this space is grouted with a mixture of 50 per cent portland cement and 50 per cent fireclay. The fireclay mortar is mixed in a tank at ground level and pumped to the swinging scaffold by a 6-in. high-pressure duplex air piston pump (Figure 20).

Figure 17 — With the casthouse floor excavated and the front of the hearth jacket removed, mechanized equipment can move inside the furnace hearth to dig and remove rubble. A section of the hearth jacket has been removed to make the opening shown.

HEARTH BRICKING

Tear-out work continues uninterrupted in the hearth as stack bricking takes place. Upon reaching satisfactory brick or concrete foundation in the furnace bottom, third quality brick and castable refractory are used to brick the hearth up to the bottom course of first quality bottom block. Brick for bottom work is brought in on a conveyor placed through the salamander tunnel. The elevations of hearth brick are relative to the iron notch and it is normal to retain the iron notch at its original design elevation and any furnace settlement is taken up in the spacing in the bosh bands. After the leveling course of third quality brick and castable refractory is in place, the new stave coolers are brought into the hearth and the front section of the hearth jacket is replaced and welded.

Figure 18 — One half of the preassembled bosh bands are rigged into place through the open front of the hearth jacket.

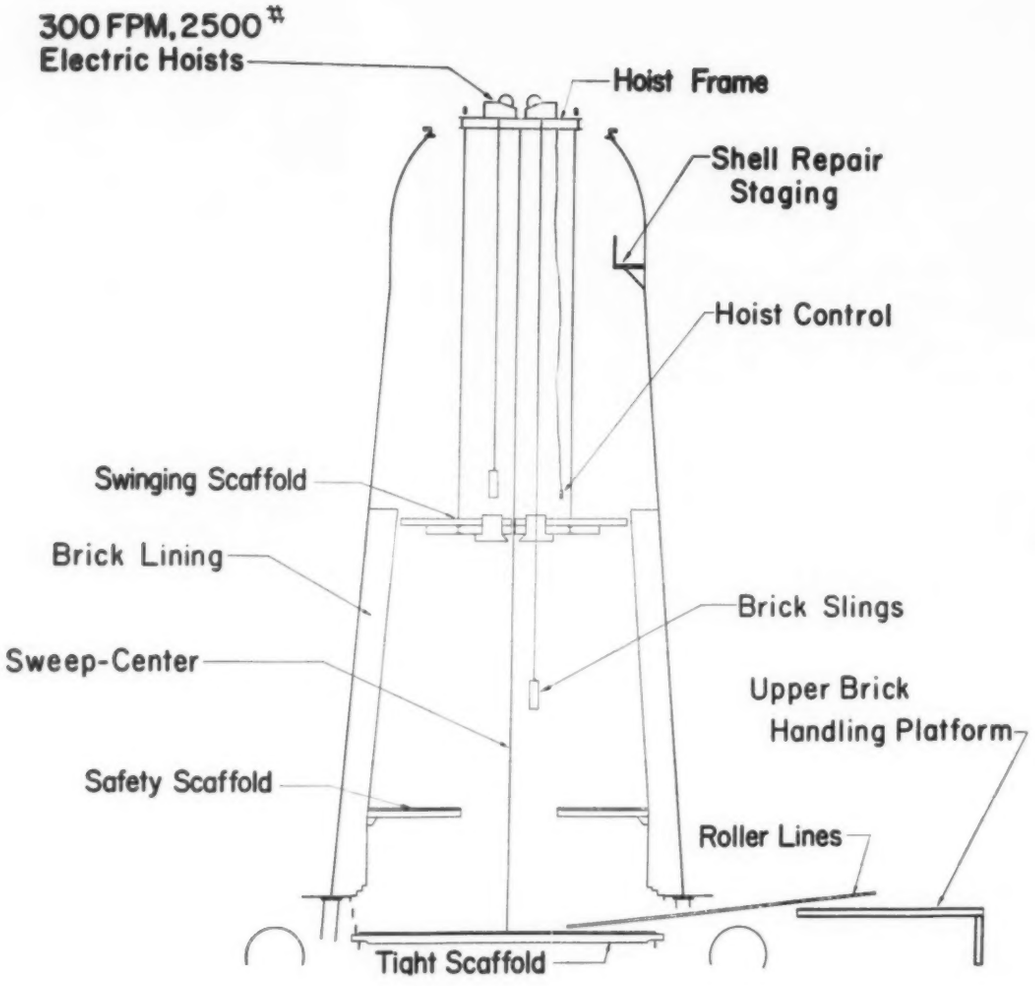


Figure 19 — The setup of equipment used for bricking the stack is shown in this diagram.

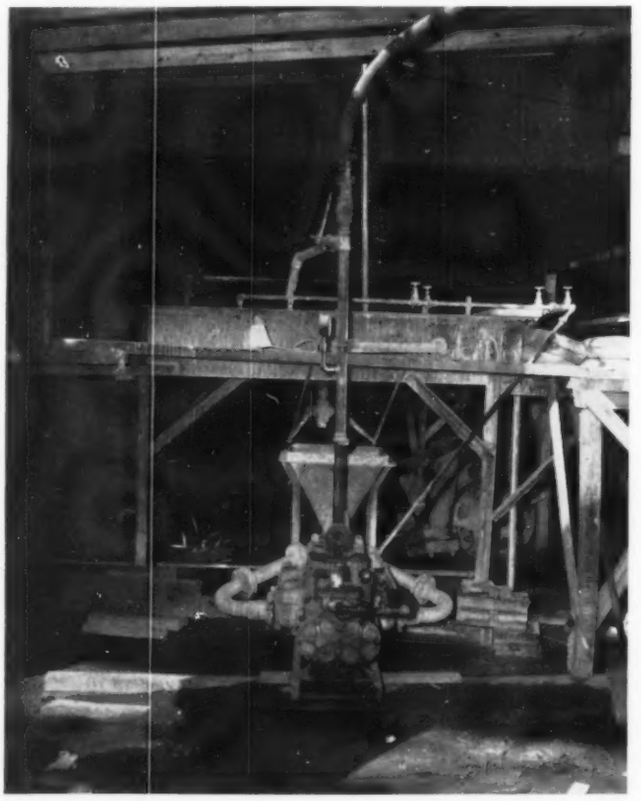
In replacing the hearth-jacket patch, excessive stress concentrations are avoided by preheating the areas to be welded and depositing the weld metal by the block-welding technique. Block welds are deposited on each side of the beveled joints and spaced along the length of the joint. Low-hydrogen welding electrode is used throughout, and all root passes and succeeding passes are cleaned or chipped with pneumatic tools to minimize slag inclusions and oxidized metal.

In order to handle materials in the hearth (Figure 21), a rotating trolley hoist is mounted under the tight scaffold. At its outer extremity, the trolley beam is fitted with rollers which rest on a circular track installed inside the second bosh band. A shaft set in a roller bearing supports the trolley beam at the hearth center. A 3-ton electric hoist is suspended on rollers from the trolley beam. With this arrangement, both radial and circumferential movements of loads are made possible.

While the hearth-jacket patch is being welded, the hearth hoist is used to set stave coolers. The centerline of each cooler is marked on the top of the hearth jacket before setting is started, and as each cooler is set and plumbed, it is clamped in place. By the time the front-patch welding is completed, the only coolers left to be set are those falling within the borders of the patch.

Palletized brick and carbon block for the hearth are brought to the casthouse floor elevation by use of the outside brick-handling elevators. From the bottom level of the temporary brick-handling platform, lift trucks carry the stock to a small 6 x 4-ft platform

Figure 20 — Mortar for the stack brick is mixed in this pan at ground level and pumped to the scaffold as required.



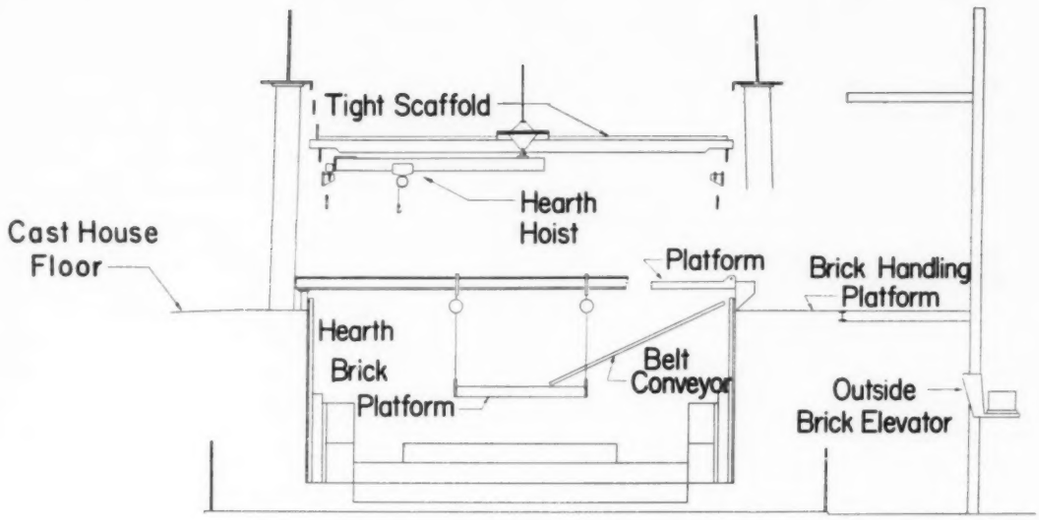


Figure 21 — This diagram outlines the brick-handling system and the equipment used for bricking the furnace hearth.

mounted on top of hearth jacket which extends into the hearth and under the hearth hoist. The hoist lowers the block or brick to the exact point where it is needed. An L-shaped hook, a pair of tongs, or slings may be used, as needed, for handling material from this platform. The pallets of hearth blocks are also placed on this platform and fed onto a 10-ft square hearth block platform by a belt conveyor. This hearth block platform is suspended by chain falls from two 12-in. beams installed across the hearth.

When the design of the hearth requires carbon brick (Figure 22), they can be purchased in 1½-in. increments, from 3 in. up to 13½ in. to compensate for any irregularity due to riveted hearth plates, hearth coolers, etc., without extensive brick cutting. A sweep-pole, set on the centerline of the mantle, is installed in the hearth for this brick which is laid up with standard carbon paste. Positioning of any carbon sidewall blocks is done to the sweep-pole, and each ring is wedged tightly into position. The space between the carbon brick and blocks is rammed with standard carbonaceous compound which has been heated in special steam-heated boxes. The width of the opening to be rammed varies between a minimum of 2 in. and a maximum of 4½ in. at the block center. A protection wall of 9-in. second-quality brick set in air-setting cement is installed in front of all carbon and continued up to the mantle.

In setting ceramic bottom blocks, each course is started at the center, set in air-set mortar, and keyed with precut keys. When the first course has progressed

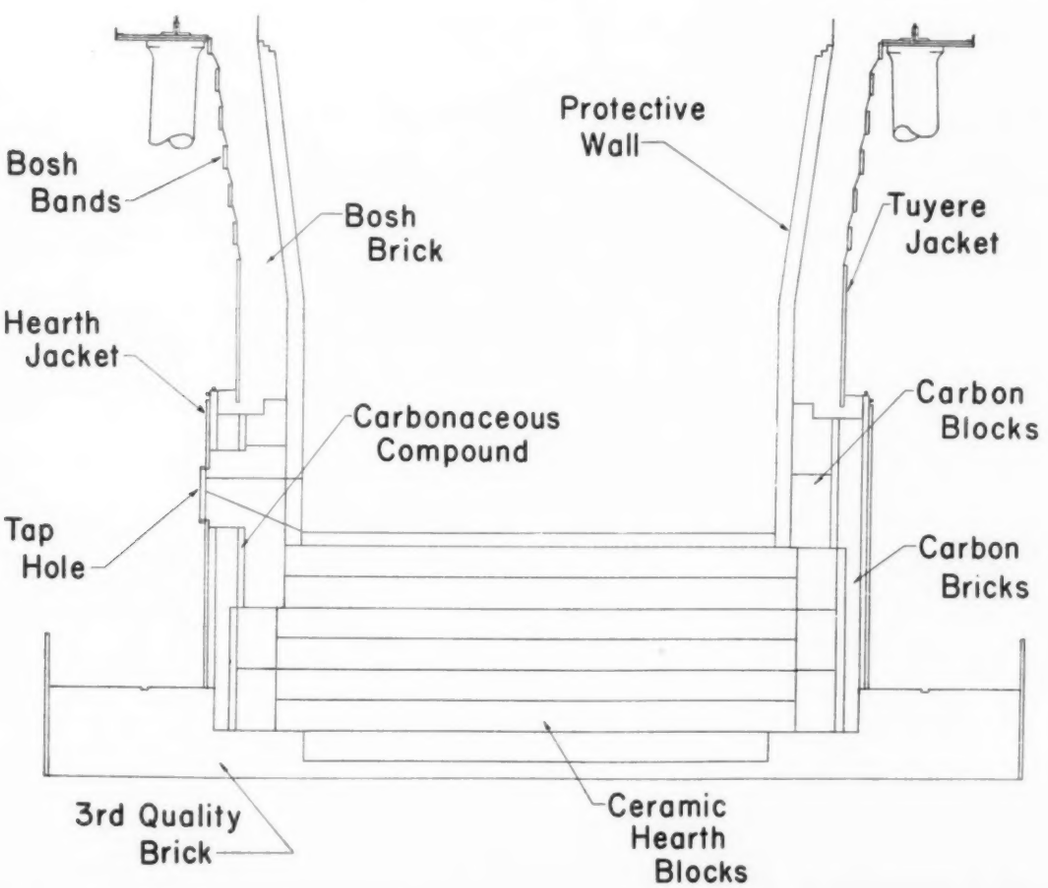


Figure 22 — This sectional diagram of a blast furnace hearth and bosh shows the various shapes and types of brick laid and their location.

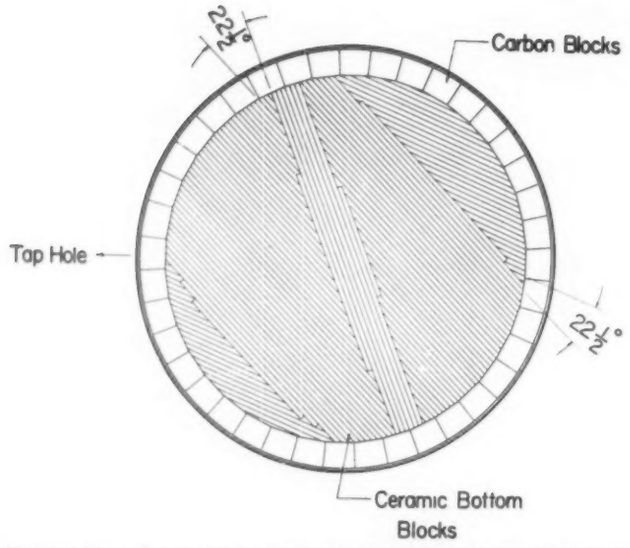


Figure 23 — Course of ceramic bottom blocks is laid in the pattern shown in this diagram to avoid continuous vertical joints in succeeding courses.

sufficiently, a lead for the second course is started with joints at an angle of 22½ degrees to the joints of the first course (Figure 23). Each succeeding course is laid at 22½ degrees to the one before it, until the bottom is complete. Grinding on the surface of each course is held to a minimum. It is important that the lateral joints of the top course be not in line with the tap hole.

BOSH BRICKING

Brickwork of uniform thickness is installed in the bosh, and is laid in air-setting cement, with special care taken to get good tight fits. Bosh coolers are set with ¼-in. joints up to the first band and ⅜-in. joints from the first band to the mantle. Plastic firebrick is used around the tuyere castings and for leveling over cooler arches. As previously stated, precut tuyere bowls (Figure 24) and piers (Figure 25) between coolers are used.

Bricking of the stack is usually completed at about the time the hearth is finished and all brick-handling equipment for the stack is removed. The safety scaffold is decked over tight and during the ensuing lunch periods the lower tight scaffold is removed.

While bricklayers are still at work in the bosh and after the stack has been completed and the brick-handling equipment cleared, top castings are replaced. Bricklayers are taken out of the furnace for short periods of time when the bell and hopper are being lowered into the furnace and when the bell is being secured to the gas-seal hood. The installation and adjustment of the balance of the top mechanism and the testing of the skip are accomplished while bricklayers are in the furnace.

After the bosh is completed, the safety scaffold is removed through the tuyeres, the hearth is cleaned and a drying-out dome is installed above the tuyere arch.

DRY-OUT

Dutch ovens are built at three of the tuyeres and the furnace is dried out for a period of from five to seven days. During "dry-out" time, the tuyere stocks, clay gun, iron and cinder runners and floor paving are installed.

During the rebuild, blast furnace equipment and auxiliaries are inspected and repaired or altered. Considerable attention is always paid to bleeders, downcomers, dust catcher, gas washer, stoves, mains, hoisthouse equipment, skip, stock house and casthouse. Renovations are usually required to railroad tracks and sewers, and yard elevation must be returned to correct grades.

"A" BLAST FURNACE

Blast furnace rebuild times are predicted on the amount of work to be done. In June, 1957, "A" Blast Furnace at Sparrows Point was blown out for a major rebuild. The hearth had been in service since 1948 producing 3,721,538 tons and the stack since 1953, producing 1,531,373 tons. The total volume of the furnace was increased from 43,202 cu ft to 45,091 cu ft, by increasing the diameter of the hearth and bosh from 24 ft-6 in., to 25 ft-6 in., necessitating the installation of a new hearth jacket, a new tuyere jacket, new bosh bands and alterations to the mantle diameter. The hearth design was of carbon-block sidewalls and seven rows of cone-23 bottom block. Major alterations were made to the bustle pipe, gas washer, skip structure, cyclone washer and hoisting mechanisms. The rebuild time from wind-off

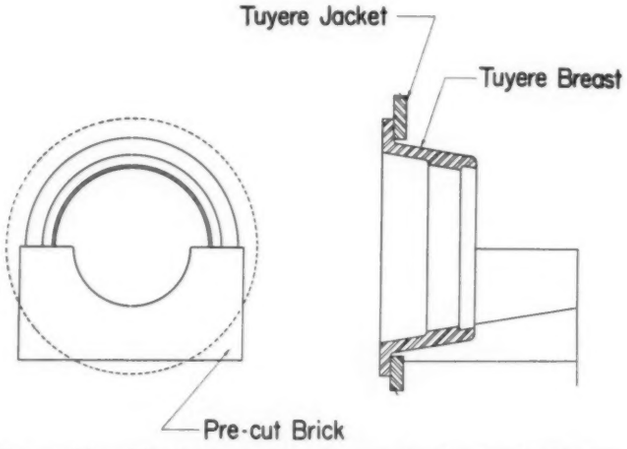
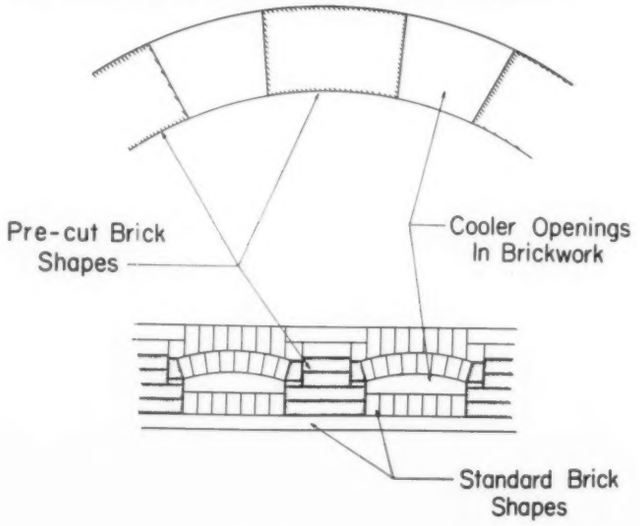


Figure 24 — The bricks at the tuyere require intricate cuts to form the shape of the cooler and by precutting of a dummy setup, brick-up time is reduced.

Figure 25 — The bricks in the piers between the bosh cooler openings are precut to reduce bricking time.



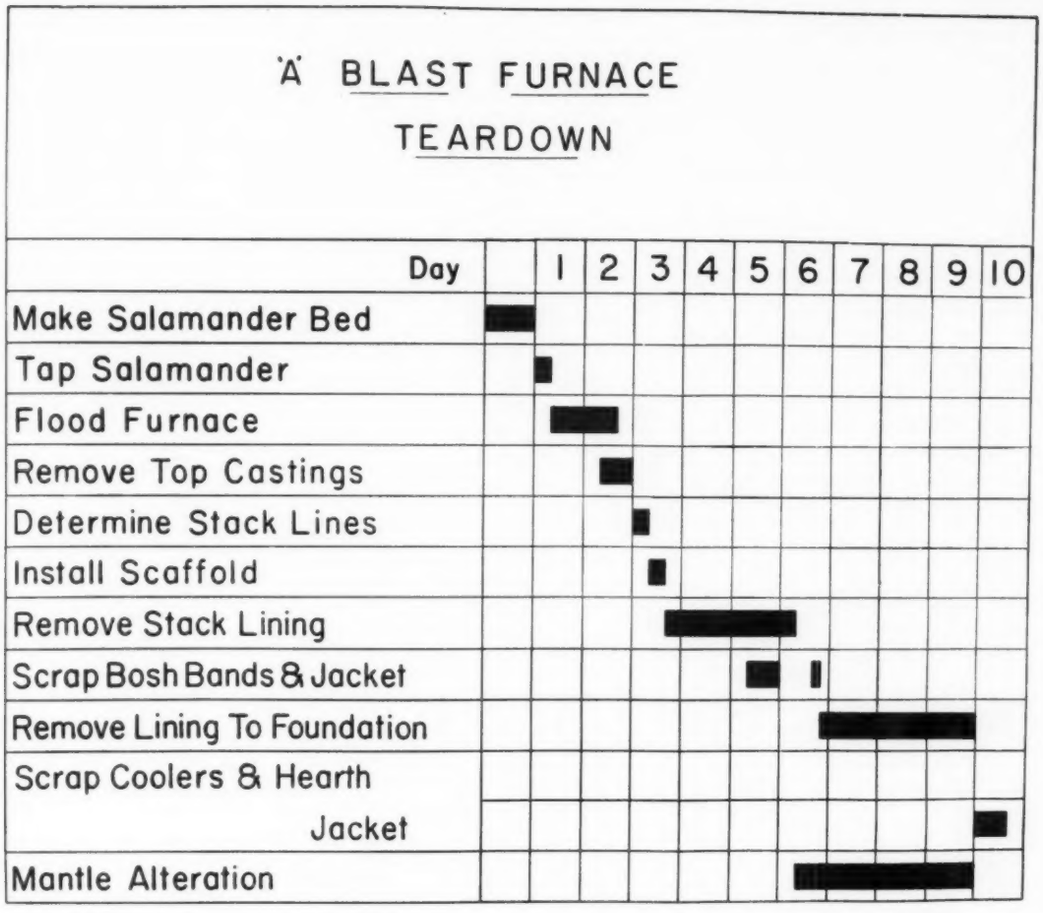


Figure 26 — The chart outlines the operations and actual times involved in the teardown of "A" blast furnace, Sparrows Point plant.

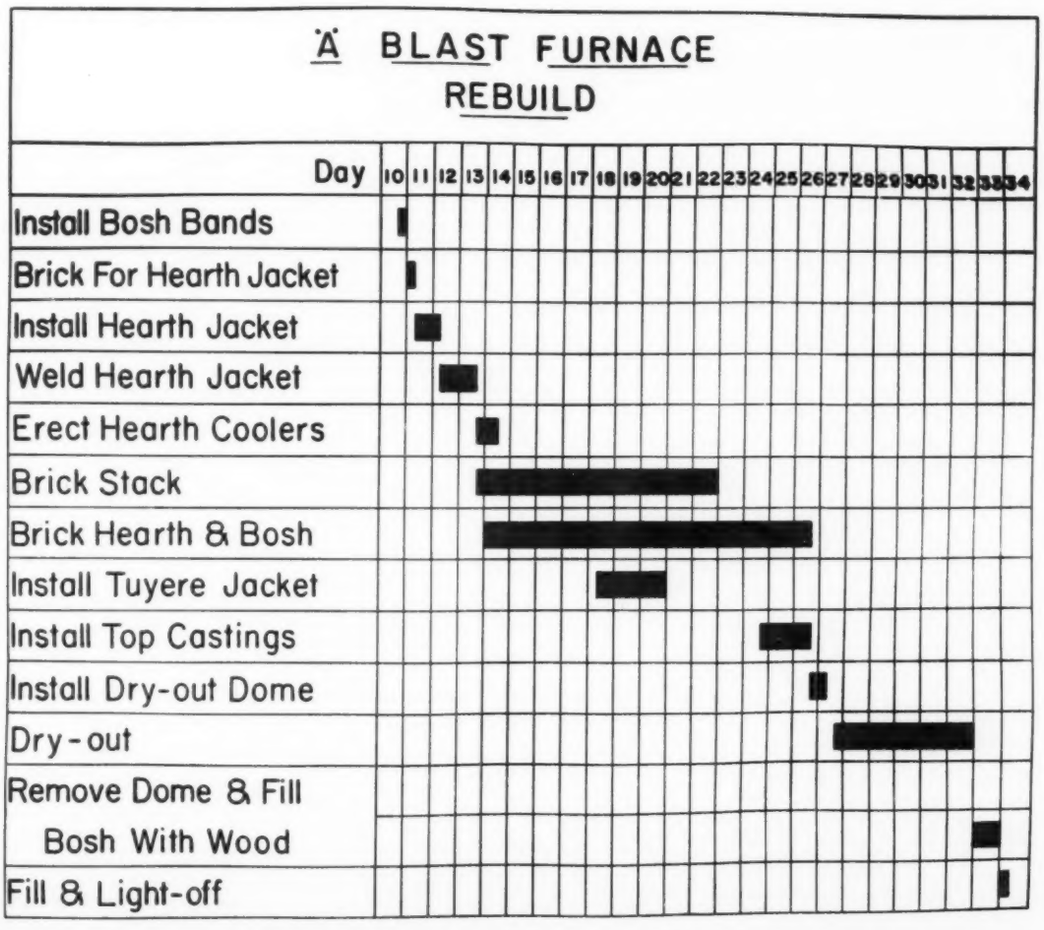

"A" BLAST FURNACE
REBUILD
Day
10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34
Install Bosh Bands
Brick For Hearth Jacket
Install Hearth Jacket
Weld Hearth Jacket
Erect Hearth Coolers
Brick Stack
Brick Hearth & Bosh
Install Tuyere Jacket
Install Top Castings
Install Dry-out Dome
Dry-out
Remove Dome & Fill Bosh With Wood
Fill & Light-off

Figure 27 — This chart outlines the operation and actual times involved in the installation of the new lining in "A" blast furnace, Sparrows Point plant.

to ready for operation was 34 days. The various operations involved in the tear-down and the actual time involved in each are given by Figure 26. The operations and times involved in installing the new lining are shown in Figure 27.

SUMMARY

There are few more intriguing maintenance jobs in a steel plant than the rebuilding of a blast furnace. It has been the purpose of this paper to present the rebuilding procedures used at Sparrows Point which might be of benefit to such work at other plants. While good methods, planning, and co-ordination as well as adequate safety precautions are essential to a blast furnace rebuild, success depends on the complete co-operation and enthusiasm of all personnel concerned. The lighting of a relined blast furnace is a moment of triumph which can only be appreciated if the job was completed without a major accident.

Discussion

PRESENTED BY

GEORGE C. LITTLE, Assistant Superintendent, Mechanical Dept., Bethlehem Steel Co., Sparrows Point, Md.

FRED E. KLING, Steel Works Engineer, Tenafly, N. J.

George C. Little: We have just had the privilege of listening to a very fine paper on the "Rebuilding of a Blast Furnace" and I would like to extend my congratulations to the author. Mr. Carl Bessent has spent considerable time in preparing this paper, and we hope it will do two things: first—pass along the results of our experience at Sparrows Point; and second—stimulate the desire for further improvement in these methods.

The one part of the relining which has presented a major problem for many years is the removal of the iron left in the hearth after the last cast. The removal of this material, commonly called the salamander, can be the cause of much lost time and considerable expense. My comments will be in the form of further development of this phase of the project.

Prior to the early twenties, the salamander was left in the furnace to cool and later removed by blasting. On some occasions, the iron was left in the furnace and a new brick wall built around it. This would seem ridiculous now, but we must remember that before oxygen became available, all the holes for blasting had to be drilled. This job alone took weeks, and resulted in a tremendous loss of product.

The first salamander tapped at Sparrows Point was in 1925. As I recall, our equipment was crude and inadequate, but over the years, we have developed methods which are both safe and effective. In preparation for this job, a sand bed must be built. This bed has been described by Mr. Bessent, but in passing, I would like to draw attention to its construction. The sand walls must withstand the hydraulic pressure of the molten iron and therefore must be of considerable width. This is particularly true with the first few mold cavities.

Since tapping hot iron into a wet area is very unsafe, the tunnel leading to the tap hole is dried with a wood fire. After the fire is removed, the hole to be used for tapping is cleaned and filled with soft coal. This coal will burn to such temperatures in the presence of oxygen that the basic iron oxide from the lance will flux clay brick. To stimulate this action, a few pieces of steel bar are fastened to the end of the first lance. The oxygen lance is made of three or four lengths of ½-in. pipe connected together. About 40 of these long lengths are placed within easy reach of the operators. Two ¾-in. diameter high pressure hoses of suitable length are connected to the plant oxygen system which carries a pressure of about 110 lb. The end of the first lance is lighted with a burning torch and then placed in the tap hole. An experienced operator can tell by the color of the plume of smoke whether the lance is cutting brick or iron. It is for this reason that we prefer to use no additive such as iron powder.

When the body of iron or a heavy iron joint is reached, the plume will become a dark reddish brown. When molten iron is reached, hot metal will start to flow from the tap hole. If the flow is weak, burning will be continued as long as it is safe for the workman to stay in front of the tap hole. Sometimes after the flow is well established, additional pipes will be burned in the hole to increase the size of the opening.

Since it is impossible to predict the size of the salamander, space is provided for about 1000 tons. This sometimes means a lot of space is not used, but we believe this to be good insurance. The amount of iron tapped varies from 300 to 1000 tons.

We feel that the tapping of this molten metal saves sufficient time to justify the effort.

Fred E. Kling: Having been in the steel business about sixty years I witnessed the time-consuming, expensive dynamiting of salamanders quite frequently. Tapping and draining the iron is a great improvement in preventing the forming of a salamander, but still is not the final solution.

The next step in the evolution is to prevent erosion of the bottom lining caused by overheating of the same at and near the center of the furnace. This can be avoided by cooling. There are various ways of doing this. One method is to extend the hearth jacket inwardly around the bottom, dished, as shown in Figure 1 of my article "Blast Furnace Design Problems" (Blast Furnace and Steel Plant for July, 1954).

Air cooling may be sufficient, especially if the hearth bottom is lined with carbon blocks because of the high thermal conductivity. However, waste water from the hearth jacket can be used and led along the bumped bottom in a thin sheet; draining it, so that in case of a breakout an explosion will not occur, as no puddle of water is existing.

At the beginning of this century, open hearth furnace bottoms were solid, laid right on top of the foundations. On rebuilds they were changed to air-cooled pan type, thus eliminating or at least minimizing breakouts.

Large mixers (two 1600-ton at Ohio Works and one at Mingo, installed in 1928) contain three or four times more iron than the largest blast furnaces. The bottoms are air cooled and to my knowledge iron never broke through them.

So why hesitate building blast furnaces with open, exposed bottoms, separated from the foundations, thereby preventing erosion of the lining? ▲

High Velocity Gas Stress Relieving Furnace

by EDWARD M. YARD,
Chief Project Engineer, Mechanical,
John A. Roebling's Sons Corp.
Trenton, N. J.

. . . . with combined convection and radiation, the new furnace at the John A. Roebling's Sons Corp. plant at Trenton provides a maximum furnace heating rate for 3/8 in. strand of 75 sec at 700 F.

IN 1954, the Roebling plant was faced with the problem of stress relieving a steel wire strand of 3/8-in. diameter in moderate quantities. It was desirable to maintain close control of this treatment in order to obtain uniform physical properties to meet close specifications. Naturally economy of investment and operation were important, as yearly production was expected to be a few thousand tons.

Product development work had been carried on pulling the strand through an open lead pan at about 700 F. This produced satisfactory physical properties, the only real objection to its use being the lead which was dragged out in the interstices of the strand. This lead in the strand was not only detrimental to the appearance of the product, but it was an important item of cost. This difficulty coupled with a low operating efficiency was sufficient to eliminate a lead pan for the job.

While it is entirely practical to carry out the stress relieving operation in an oven as a batch process, this method had been ruled out at the start. The development people did not wish to take any chance that the strand might take a set in a coil or on a reel during the stress relieving. The strand had to be kept perfectly straight. Since shipment is normally made on a wooden reel, any batch system would have necessitated rereeling or substitution of a metal shipping reel. These considerations eliminated any batch process.

At one point in the discussions it was thought that it would be desirable to anneal the strand in line with the strander. For a time therefore induction heat received some study, even though its first cost and operating cost would be higher than for any other means considered. The idea of stress relieving in line was finally abandoned because of inflexibility, difficulty of control, and low utilization of capacity as a result of strander stops. Induction heat received no further real attention.

Radiant type furnaces were ruled out by the low effectiveness of radiation at the 700 F level. The heating zone could not be held to reasonable dimensions without the use of an excessive heat head. This could cause product spoilage in the event a strand stopped or slowed down momentarily. It was not possible to take this chance, or to tolerate the poor control a high heat head usually entails.

Salt baths, electric resistance heating, etc., were passed over as not applicable for this purpose. Operating difficulties or costs would make such equipment unattractive. All forms of electric heating have a high energy cost in our area and are applicable only in special circumstances.

With the idea of heating in line with the strander disposed of, the use of a convection type furnace could be considered. Had it been necessary to stress relieve in line an excessive length of furnace would be required to match stress relieving speed to strander speed, and the control of temperature rise during stoppages would present a problem. The furnace could now become a multistrand unit of suitable length to give reasonable speeds with a single pass. Being a separate operation, variations in production could be handled by varying the number of strands run, or the operating shifts of the furnace compared to the strander. More than one size can be run at a time if required. It would also allow more flexibility in the range of sizes that could be handled as compared, for instance, to induction heat. Reruns are also possible in some instances of incorrect physicals. Furnace failure would not interfere with stranding.

The efforts therefore centered on the development of a suitable convection furnace. It was hoped that by the use of high velocity recirculation, the size of the equipment could be held down and satisfactory running speeds attained. Both of these things would help to keep first cost down.

To design such a furnace required the use of applicable heat transfer data or some method of approximating useful factors. This was not in available handbooks or texts as this furnace did not clearly resemble boilers or heat exchangers as normally built. In such units the

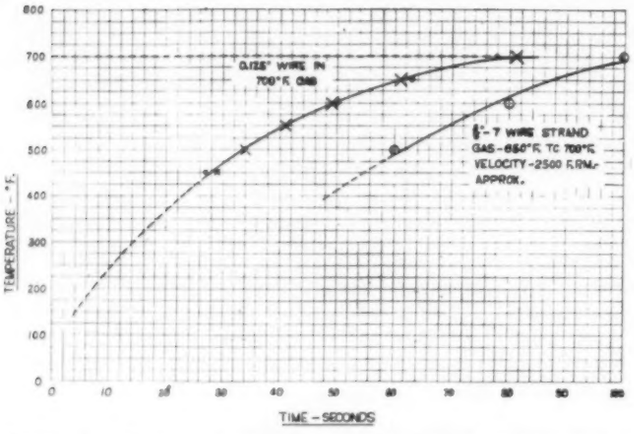


Figure 1 — Curves show data or test results on heating of ⅜- and ⅛-in. wire.

gas flow is either at right angles to the heat absorbing surfaces or is confined within tubes offering a large surface. It appeared unlikely that it would be possible to maintain a flow at right angles to the strands or to achieve any reasonable ratio of work area to furnace wall area.

To the hope that this might be partly offset using a gas flow velocity as high as practical, the lack of data was a handicap. So it was decided to measure heating times for wires and for strand in gas streams of known temperature and velocity. Unfortunately these flows were at right angles to the axis of the strand or wire. However the measurements were made on the exact material to be heated and at the expected temperature. Temperatures were measured by using a thermocouple as the center wire of a strand, and reading output with a potentiometer. Color indicating sticks were also used. Results with these for individual wires were checked by substituting a thermocouple for the wire.

Measurements made in this manner are shown in Figure 1. Times of two minutes or less were indicated for these conditions. Tests of the physical properties of wires taken from strand sections so treated showed that the desired properties were attained. If the same or better heating rates could be had with flow parallel to the wire by means of increased velocity of gas circulation, then such a furnace appeared practical.

There was no time or equipment available to set up any reasonable simulation of the furnace in mind, so some check calculations were made. These indicated that even at relatively low transfer rates a sufficient mass of hot gases could be circulated to insure a reasonable approach to heating times of 90 seconds for a ⅜-in. strand. Again, this would yield a practical design and equipment of reasonable size could give desired tonnage with room for expansion.

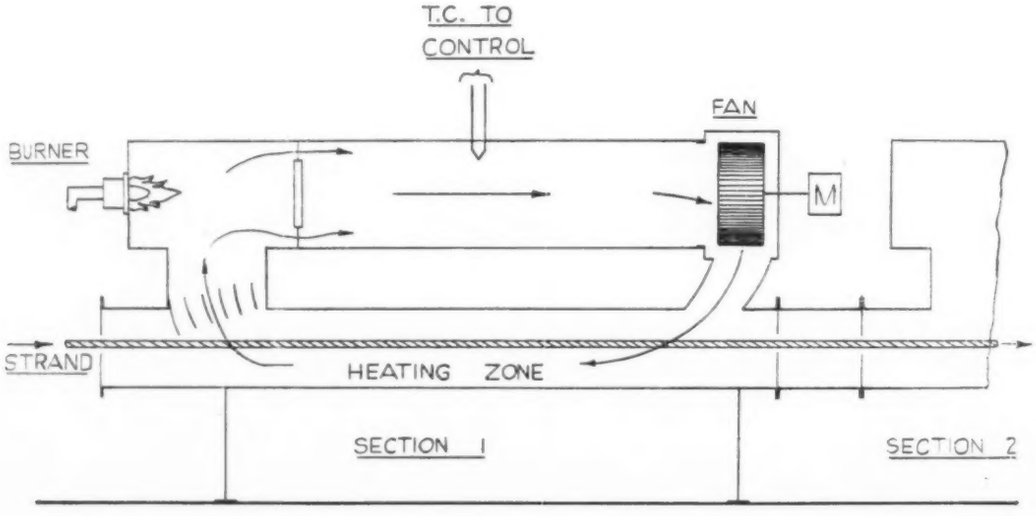
It was therefore decided to proceed with a furnace design to stress relieve ⅜-in. steel strand on the basis of these heating rates. There was sufficient process flexibility to tolerate some deviation from what expectations, even to as long as 2½ minutes to heat the strand. Of course anything better would have been fine.

Using a furnace fifty feet long, it was expected to get wire speeds of 20 to 50 fpm and that the job could be done in one pass straight through. The heating chamber could be a duct with a slot at each end for the strand to enter and leave, having two side inlets to introduce hot gases and withdraw cooled ones. Because gas travel would be parallel to wire travel, turbulence would have to be depended upon to produce the contact or scrubbing action for good convection transfer. Therefore as high a velocity as seemed economical would be used. To keep heating time to a minimum, a maximum temperature differential was desirable. This of course went hand in hand with the high velocity gas circulation, as there would be a minimum temperature drop during each circuit.

Using a hot fan to recirculate the gases through a direct-fired gas heater provided a simple source of a hot gas stream. A short flame high capacity gas burner is fired axially into a steel cylindrical chamber into which air is pulled radially. The heating chamber contains a baffle to improve mixing, and is connected by a cylindrical duct to the inlet of the hot fan. The insulated hot fan completes the mixing and discharges the reheated gases into the hearth through a curved transition piece which serves also as a direction changer. The hot gas flows along the wire to the scoop vanes which redirect it into the reheating chamber on the suction side of the hot fan for reheat and recirculation. The furnace is divided into two sections, each separately fired and controlled.

The furnace construction is shown in Figure 2. The heating chamber or hearth is simply a rectangular

Figure 2 — Schematic diagram of high velocity stress relieving furnace.



duct of such cross section as to accommodate the strand and handle the gas stream at a circulating velocity of about 7000 fpm. This is provided with inlet and outlet flanges. At the furnace inlet a silicon carbide wear bar is located over which the strand rides. This end of the heating chamber is free to expand outward, and in so doing slides on insulating guides in the outer shell. There is considerable differential expansion between the inner duct and the outside shell. Movements of 1-in. have to be allowed for.

The furnace shell is a steel box with channel irons as sidewalls and sheet bottom and top plates. The bottom and top are insulated with pellets, the sides with block; this eliminates the problem of settling. The rigid side members give the frame stiffness for mounting in almost any manner.

The gas reheaters and circulating fans are mounted on top of the two furnace sections and are connected with them by insulated round ducts. The only venting provided is through the entrance and exit slots of the heating chambers.

The furnace sections are joined by a box which carries an intermediate silicon carbide wear shoe to keep the strand off the bottom plate. It can be dropped to allow replacement of this shoe or inspection of the furnace interior. In a completely welded unit fifty feet long, this was thought desirable.

Each furnace section has a total burner capacity of 700,000 Btu and is separately controlled by a thermocouple in the gas stream just after the burner section. The instrument is a round chart recording controller of the potentiometer electric type with reset action. An electric drive positions the combustion air control valve and the air flow controls the fuel. With a bare thermocouple, the response is rapid and close control is achieved. The combustion system is thoroughly interlocked to minimize explosion hazard or equipment damage.

From an operator standpoint the furnace is very simple to start. Turning on the combustion air blower automatically starts the purge timer in the flame failure relay. When it is timed out both the red and green signal lights go on. Now pushing the "start" button will ignite the burner electrically. The control instrument is equipped with an auxiliary contact which will start the recirculating fan automatically when the furnace reaches 600 F. The fan is not designed to handle the cold air load.

The furnace is equipped with a number of safety interlocks. The purpose of the air pressure switch is twofold. First, it assures that the combustion blower is running. Second, it activates the purge timer in the flame failure relay.

The purge timer keeps the furnace from being lighted until it has been purged of any accumulation of gas that might have leaked in while it was idle. The gas pressure switch shuts the furnace down in case of a gas pressure failure. The flame failure relay and normally open start button will prevent it from starting itself when the gas pressure is re-established. Red warning lights are mounted on top of each instrument panel and flash if the furnace shuts down while in operation. This has been found inadequate, and will go to horns. The temperature control instrument is equipped with a fixed auxiliary contact. This contact is adjusted for

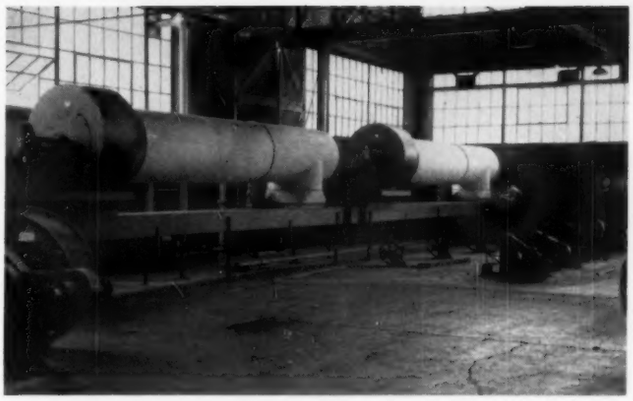
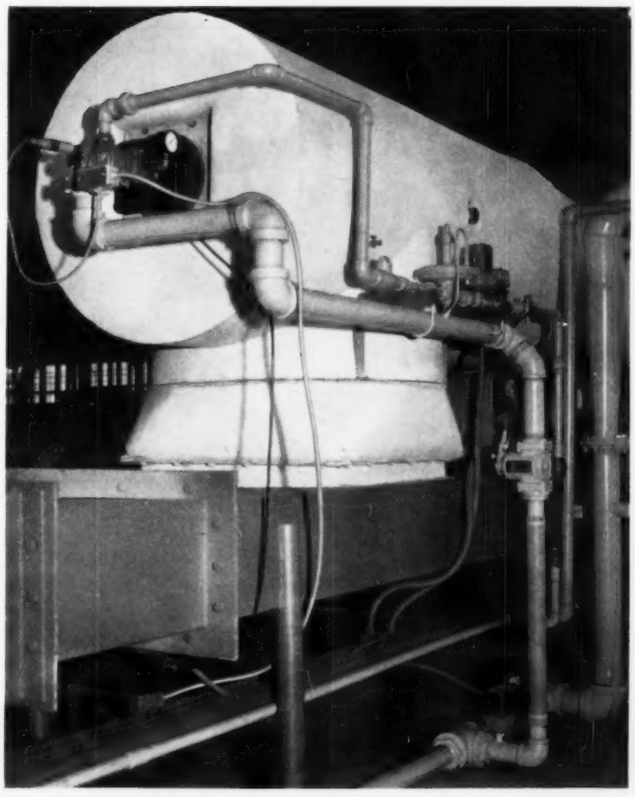


Figure 3 — Furnace is divided into two sections.

600 F; it starts the recirculating air blower at that temperature. This in turn pressurizes the duct pressure switch which starts the warm up cycle timer. The purpose of this timer is to prevent the recirculating air blower from cycling and to limit the time it handles the cool gas load. It temporarily shunts the auxiliary contacts in the controller. When the recirculating hot air blower starts, it pulls cool air from the lower duct past the thermocouple, dropping the temperature below 600 F which opens up the auxiliary contacts in the controller. This would stop the recirculating hot air blower until the temperature at the thermocouple rose once more to 600 F, at which time the recirculating hot air blower contacts would once again close. This cycle would be repeated until all of the air in the furnace was up to 600 F. Having the timer across the contacts prevents this cycling by keeping the blower running.

The recirculating air blower is so designed that it develops full horsepower with the air at 600 F. Running the fan at a lower air temperature will overload the

Figure 4 — The furnace is a successful production unit.



motor. The starting time is so short that the motor does not overheat. It is protected during this interval by its thermal overload fuses and the timer which prevents extended operation cold. The fan manufacturer does not recommend having the fan idle, but proper lubrication of the bearings should prevent any serious damage to the fan.

The furnace has been operating at a thermocouple temperature of 850 F. Actual heating rates of between 32 and 36 fpm have been obtained when running $^3/_8$-in. steel strand, the latter when the maximum fan rating was reached by increasing speed until maximum hp was required at 600 F as previously stated. It is probable that the heating rate would allow speeds as high as 40 fpm. In the interest of product quality, it has been felt unwise to push speeds to the limit. In any event these speeds are squarely in the hoped for range. The furnace is a successful production unit and has justified expectations. Its flexibility and capacity have been adequate to needs. The furnace as completed is shown in Figure 3.

The calculations have been left for the last part of this paper so that if need be they can be skipped without loss or detriment. The reader is warned that in spite of anything the calculations do or do not show, the furnace works.

In reality the design was based upon the measured actual heating rate for the actual strand in gas streams at operating temperature. The gas flow was at right angles rather than parallel to the strand and at a velocity 65 per cent below that in the furnace. With confidence ill supported by these facts, it was decided that the effects of the higher velocity would offset those of parallel flow.

The following figures did, however, have some effect on the thinking:

1. Radiation effect:

   1 ft of $^3/_8$-in. strand exposes 18.9 sq in. of surface and weighs 0.287 lb.

   For a furnace wall temperature of 800 F and a wire emissivity of 0.55, 350 F average wire temperature, the heat transferred is:

$$\frac{18.9}{144} \times \frac{3900-570}{3600} \times 0.55 = 0.0675 \text{ Btu per sec}$$

   78 Btu per lb $\times$ 0.287 lb = 22.4 Btu required to heat 1 ft of strand to 700 F.

$$\frac{22.4}{0.0675} = 332 \text{ seconds to heat } {}^3/_8\text{-in. strand to 700 F}$$

   by radiation.

2. Parallel gas flow convection effect:

$$\frac{5 \times 0.132 \text{ sq ft} \times 450^\circ}{3600} = 0.083 \text{ Btu/sec}$$

$$\frac{22.4}{0.083} = 270 \text{ seconds to heat } {}^3/_8\text{-in. strand to 700 F.}$$

Neither radiation nor low velocity parallel gas flow convection would have been adequate for our purpose.

3. High velocity convection effect:

   In an attempt to estimate heating in high velocity gas, it was hypothesized that the heat transferred would be equivalent to that carried by the displaced gases. Heat would be transferred to the extent of that available in the gases shouldered aside by the strand. At 850 F and 12,000 cfm

$$\frac{0.0304 \text{ lb per cu ft} \times 12{,}000 \text{ cfm}}{1.67 \text{ sq ft} \times 60 \text{ sec}} = 3.65 \text{ lb per sec per sq ft}$$

$$3.65 \times \frac{0.1104 \text{ sq in.}}{144} \times 450^\circ \times 0.24 = 0.302 \text{ Btu per sec}$$

then

$$\frac{22.4 \text{ Btu}}{0.302} = 74 \text{ seconds to heat } {}^3/_8\text{-in. strand to 700 F.}$$

This result sounded encouraging and has proved to be very nearly right. The actual maximum furnace heating rate for $^3/_8$-in. strand is 75 seconds to 700 F with combined convection and radiation.

Discussion

PRESENTED BY

C. O. KNIERIM, Manager-Heat Treat Sales, Industrial Furnace Div., The Gas Machinery Co., Cleveland, Ohio

EDWARD M. YARD, Chief Project Engineer, Mechanical, John A. Roebling's Sons Corp., Trenton, N. J.

L. C. PESKIN, President, Thermal Research & Engineering Corp., Conshohocken, Pa.

J. H. KLINK, Combustion Specialist, Industrial Heating, General Electric Co., Shelbyville, Ind.

C. O. Knierim: Our company has done similar work on high velocity heating—except for a different application, and found there is a definite relation between gas velocity exposed surface area.

I have three questions I would like to ask Mr. Yard and hope time will permit his answering them:

1. Do you think by increasing the heat input in the first section that production could be increased or furnace length shortened?

2. Does any marking of the strand occur from rubbing the silicon carbide support?

3. Do you think heating time could be further reduced by making the chamber circular in cross section and having spiral vanes on inner wall to give further agitation or spinning of the gases?

Edward M. Yard: On the question, would increased input to the first zone increase the heating capacity or production of a furnace as nearly as we can tell, there is such a small temperature drop per circuit for the gases, that unless we also increase the temperature in the first zone I do not know that we can use the increased heat input.

The full load temperature drop per cycle is about 25 degrees for the gases and we are not really using the full openings on the existing burners. That means it would be necessary to increase the temperature to heat faster and we did not want to do that. There are momentary stoppages on the strands, while they attach another one or slow it down to take a reel off, and it was felt desirable to stay fairly close to the stress relieving temperature. Of course if you did pick the heat head up, it would naturally heat more rapidly.

As far as I know, there has not been any marking from the silicon carbon strand, at least none that proves objectionable in this product. Having looked at the surfaces of a great many reels I have never noted any marks. There is, however, because of the temperature, a slight discoloration of the wire surface. You could say it was a bluing action because of the temperature to which we are heating it in an oxidizing atmosphere.

I do not know the answer to the third question. We never tried any circular heating chamber with spiral vanes. It is entirely possible that that would work. Anything that gave more turbulence, brought more gas in contact with a strand per unit time would certainly help. Whether the complication of stringing the strand in a circular pattern would be enough to make it undesirable I do not know. Neither do I know exactly the answer to whether it would materially increase the heating rate.

L. C. Peskin: We wish to congratulate Mr. Yard on his clever solution of a difficult heat-treating problem. It has been our good fortune to have been called upon to furnish the high velocity gas producing components of this ingenious furnace. Having long been an advocate of heat transfer by high velocity techniques, we were naturally very happy to see the very successful application made by Roebling, adding to the ever-increasing number of similar successes for high velocity convection heat transfer in a broad range of metal heating problems.

The furnace created by Mr. Yard and his associates represents principles associated with high velocity, high speed heating being carried out at such low temperature levels as to make convection heat transfer the dominating and most significant mechanism involved in the heating phenomena. We might point out that with the same type of high velocity combustion system, as used in this special furnace, high velocity heating is being carried out in a variety of metal processing at temperature levels approaching 3000 F or higher, and with gas velocities of 400 fps and higher. In these high temperature applications, while radiation must necessarily play a part in the heat transfer mechanism, transfer of at least equal magnitude is produced by the unusual forced convection effects resulting from the velocities and gas temperatures employed. Under such conditions, heating of materials with low emissivities can be carried out at rates and with uniformity not possible with heat systems dependent mainly upon radiant heat transfer. In the case of high emissivity materials, heating with combined high velocity convection and radiation can be made to equal or better the results offered by pure radiation systems with much greater flexibility and economy in the use of fuels as well as with less complicated equipment and maintenance.

We are somewhat puzzled by Mr. Yard's mathematical analysis of the explanation of the high velocity convection effect. While he makes clear the assumption upon which he bases his analysis, we are somewhat surprised by the unusual close correlation between the calculated speed for heating the strand and that obtained experimentally. This may be sheer coincidence or a useful empirical method for calculating the heat transfer to be expected in a high velocity convection process. I do not know whether Mr. Yard was aware of it, but the hypothesis upon which he made his calculation is the sort of thing that would be applicable to what is known as the "mixing problem." One would hardly expect the law of mixtures to be applicable to a fluid flow phenomenon of this type. After considerable experience with the design of a variety of heat equipment involving high velocity convection heat transfer, we have nothing to indicate that the well established principles of heat transfer and fluid flow are not sufficient to describe the results to be expected. What is probably surprising to those who are dealing with high velocity for the first time is that various coefficients which are necessary in such calculations have an entirely different order of magnitude from the values we have been accustomed to using when dealing with the more conventional low velocity problems of fluid flow. The extreme turbulence and other effects associated with the high velocity gas flow do result in coefficients which if applied to the usual laws of heat transfer, would give the results to be expected from the Roebling furnace.

As Mr. Yard knows, we are at the moment manufacturing a new set of high velocity air heaters which are to go into a similar furnace for his company. The new specifications call for a somewhat higher temperature and stainless steel construction. I am wondering if Mr. Yard would care to comment on the conditions which create the need for these specification changes.

Edward M. Yard: I would like to say that with regard to radiation giving ununiform heating due to variable emissivity of the wire surface, that is all too true, as we often find out in our equipment. With regard to the calculation, we do feel that it is largely accidental, but it gives the right answer and we were unable to find any coefficients that we felt applied to the conditions we were using. Maybe we ought to get together with you and find out what data you have.

So far as the change in specifications for the heaters for our company, those I do not believe apply to a furnace in our plant but to a furnace in Pueblo. What their reason is for wanting to go to a higher temperature I do not know. We would not want to do so ourselves because we feel that we would like to stay away from a high heat head. Then if the wire slows down we do not have to worry about serious alterations of the physical properties. We can stand quite a variation in speed while stringing up and starting up, and I think we can stand a stop of maybe two minutes without harming the wire. On the higher heat head this might not be possible.

I know that they have talked about a higher heat head in their equipment at Pueblo so I guess they are going to take a chance on it.

J. H. Klink: The process of stress relieving wire at 700 F in a continuous furnace presents many varied problems for furnace designers. This paper is an excellent presentation of the many factors of heat transfer which must be considered in the design of a relatively low temperature furnace. Utilizing the basic heat transfer formula for counter flow heat exchangers we, too, have designed and built several units very similar to the furnace described in this paper. These units, which are only five feet long, are annealing copper wire; with a surface area of approximately one-half of the $\frac{3}{8}$-in. standard wire, processed in the described furnace, at 700 F at 30 fpm with a gas temperature of 1100 to 1200 F. We have had no difficulty in controlling the exit wire temperature within metallurgical limits.

Has the author experimented with using higher gas temperatures to increase the production on this furnace? Calculations of the increase in log-mean temperature difference in raising the head temperature from 850 to 1150 F indicate the unit could have been one-half as long and therefore, on slowdowns, much less material would be in the furnace.

Have you had any difficulty with burner stability because of the high velocity across the burner face?

Have you run a velocity transverse across the heating duct? We found in our experiments that the physical shape of the heating duct was very critical to obtain high effective velocities along the wire.

Have you ever checked the gas temperature at the exit of the recirculating fan?

Edward M. Yard: Your copper annealing furnace was certainly a very interesting application. We have some annealing furnaces in connection with some enameling ovens and the temperatures at which we run them correspond roughly to the temperatures that you mentioned, and the results are approximately the same. I think you probably built the equipment for us.

In regard to the higher gas temperature, I have given the answer to that question in various ways. We wanted to stay away from the increased temperature, whether rightly or wrongly, so as to take no chance whatsoever with the possibility of overheating the strand during a stoppage. We are not performing an annealing operation. On an annealing operation, when you get there you are there, and a little more does not make any real difference.

With this unit we are stress relieving; we are not annealing, and it is a time and temperature proposition. We have a little flexibility if the temperature level we are choosing to stress relieve is not too high. If we use a higher temperature the process becomes more and more critical. If we used lower temperatures, we could take hours to do it. But we do not want to take hours if we can help it.

We have not had any trouble with burner stability. We did have to get the combustion mixer set up properly in the beginning, but I would not say that we had any real difficulty.

We have not run any velocity traverses on the furnace. If we wanted to, we might have done that before building it, had we the time. Of course, when it was built there were enough other problems and we never got around to it. I fully intended to do so before I came out here but we have not done it yet.

The thermocouple location in any furnace is a very questionable thing and, as far as we know, the gas temperature is quite uniform through the unit. I do not remember the results of any tests taken as to the fan We did hope that the fan would iron out the temperature of the gases. With the baffle plate in the heating chamber and the thermocouple located downstream quite a distance, we felt that we would screen off most of the radiation effect and that we would be close enough to gas temperature to satisfy our needs. We do know that there is only about a 25-degree change in gas temperature from the outlet of the heater to the inlet after making one cycle through the furnace. ▲

Tube Mill Practice

A selection of articles from the IRON AND STEEL ENGINEER on various phases of tubemaking.

(Published in 1953)

Practical information on layout and operation of facilities for seamless, butt and electric weld pipe, a field in which little information has been published...23 articles by 20 authoritative writers ...invaluable for engineers, operators, trainees and students.

$8^1/_4$ x $11^1/_4$ in.....196 pages, illustrated, clothbound

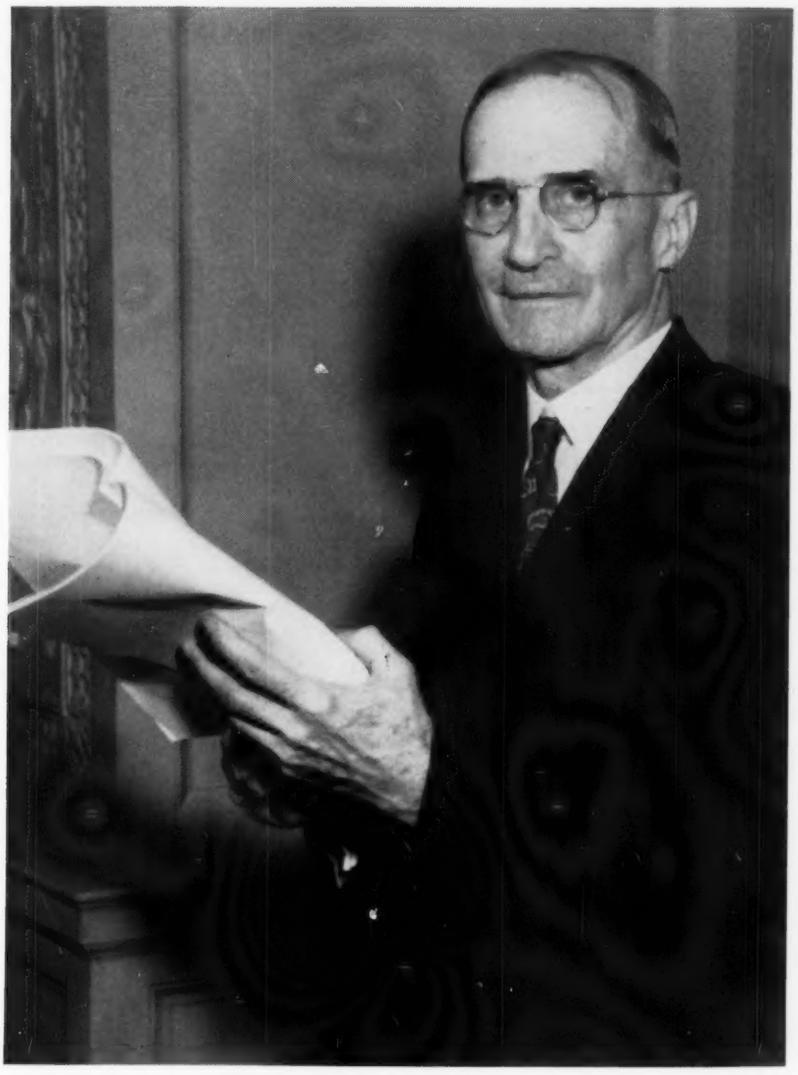
Price: To AISE Members...$2.00

To Others.....$4.00

ASSOCIATION OF IRON AND STEEL ENGINEERS

1010 Empire Building

Pittsburgh 22, Pa.



James Farrington

1873–1958

JAMES FARRINGTON, founder and first president of the Association of Iron and Steel Engineers, died January 16 in the Ohio Valley Hospital, Steubenville, Ohio. He was 84 years old.

Mr. Farrington was born December 28, 1873, in Terre Haute, Ind., and graduated from Rose Polytechnic Institute in electrical engineering in 1896. He received his master's degree in 1900. In 1893–1895 he was tennis champion of Indiana.

In 1903 Mr. Farrington became the first superintendent of the electrical department at LaBelle Iron Works, now Wheeling Steel Corp. He was made special assistant to the chief engineer in 1951 and retired in 1954. He was very active in civic, church and masonic affairs.

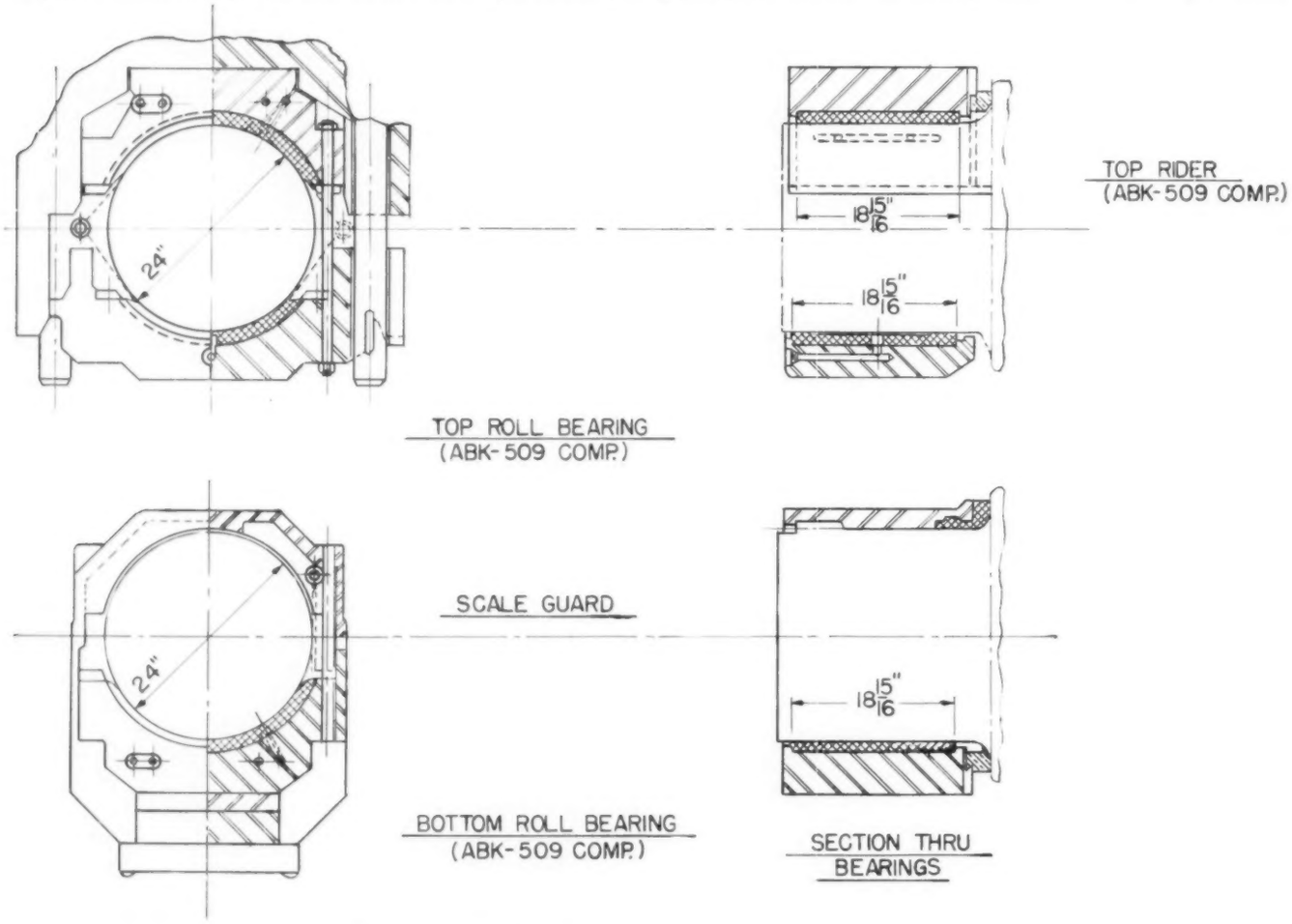
Mr. Farrington pioneered in the electrification of the steel industry and in the safety movement. Throughout his life, he maintained his interest and activity in AISE, of which he was a life member and honorary director.

Fundamentals of bearing protection require polished roll necks, clean, cool, and plentiful cooling water, dependable grease source, scale guards, and accurate performance records.

Primary Roll Neck Bearings and

By GEORGE SACKERSON, Superintendent
Blooming Mills, Billet Mills, Rail Mill, Splice Bar and Tie Plate Shops,
Bethlehem Steel Co., Lackawanna, N.Y.

Figure 1 — Both top and bottom bearings of this blooming mill set are fabric. Bearing loads of 1625 psi, grease flow of 11.4 oz per hr on each bearing, and water flow of (calculated) 16 gpm result in a normal average bearing life of 118,000 tons.



Their Protection

THERE are very few locations in a modern steel plant where an individual piece of equipment is called upon to render greater performance under more adverse conditions than is demanded of the primary mill roll-neck bearing.

The average primary mill bearing is only slightly more costly than a suit of clothes and yet, its performance has a great influence on mill yields, quality of product, mill production and cost of operation. So it becomes an item which, by virtue of its low cost, must be expendable to prevent far greater losses in some other phase of operation. This, in turn, can be interpreted to mean frequent bearing changes to accomplish the end result, or it can mean a planned program of bearing protection which will result in protection of mill rolls and improvement in operating practices. There is little doubt which interpretation is preferred by operating and maintenance people.

Protection of a plain bearing is easier said than done because the adverse conditions mentioned initially include severe shock and sustained unit loads, proximity to high heat, exposure to normal mill dust and water impurities, and the ever present abrasive action of mill scale particles. The successful counteraction of these adverse conditions can only be accomplished by proper basic design, followed by intelligent operation and maintenance.

Proper design presupposes a good knowledge of the bearing materials to be employed, fundamentals of lubrication, allowable limits of bearing wear and tolerances, and last but not least, the required frequency of roll adjustments and changes. It cannot be stressed too highly that the single requirement of frequent roll changes can often place restrictions on design which will result in poor bearing protection at the expense of fast roll changes. The figures in this paper indicate much more clearly than words, bearing assembly designs which afford good protection and still allow fast roll changes. The theoretical aspects of bearing performance under loads, frictional forces, design curves, etc., serve the engineer as a valuable tool for intelligent thinking in design, but for the purpose of this paper, discussion of the subject can be left up to the authorities.

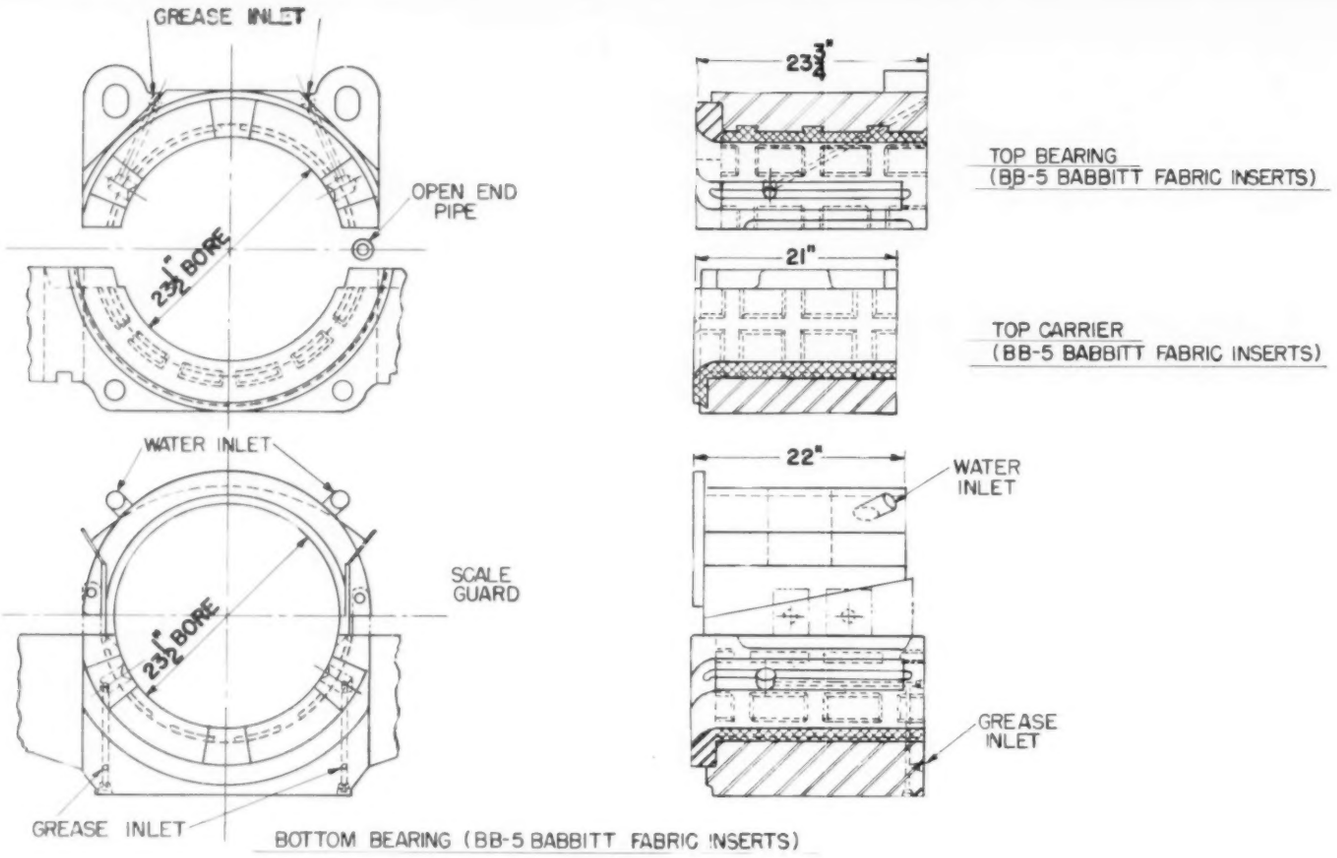
The two materials most commonly employed in plain bearings are lead-base babbitt and the fabric impregnated phenolic-resin or composition. Each has its limitations under operating conditions and these limitations cannot be disregarded in design. In many successful designs, both materials are supplemented by bronze grease grids and thrust collars.

First, fabric bearing materials are usually laminated cotton duck, impregnated with phenolic synthetic resins. They have a higher resiliency than most metals, being in the neighborhood of 0.002 in. per 1000 psi per in. of thickness and the fairly high impact strength of 10 to 14 ft-lb per sq in. Both are important in considering vulnerability to shock loads. They are known to sustain operating loads up to 6000 psi without cold flow of the laminate and their compressive strength averages about 40,000 psi. The coefficient of friction of fabric varies considerably with speeds and loads, but under 200 fpm only light amounts of grease or oil are required to supplement straight water lubrication.

On the other hand, fabric is a poor conductor of heat, having a conductivity of only 2.5 Btu per sq ft per degree F per in. of thickness. Accordingly, it needs copious supplies of cool, clean water to effectively remove all the frictional, radiated and conducted heat from the roll-neck and bearing shell. Fabric should never be used at temperatures in excess of 300 F, even under no load conditions. Conformability of fabric to a non-uniform journal surface is poor and non-scoring characteristics are very poor. Use of fabric, therefore requires excellent scale guards and a polished roll-neck free of even such minor imperfections as light oxidation pitting. Embedability properties to foreign objects are, of course, practically nil. In consideration of fast, simple bearing changes, fabric section uniformity and ease of handling permits design of bearings which can be changed without recourse to outside shop work.

Babbitt bearings, on the other hand, have many physical properties and operating characteristics very different from fabric. Except in cases of high heat, superior bondability and fatigue strength calling for tin base babbitt, most primary bearings are lead base. Lead base babbitt has poor resiliency and impact strength compared to fabric, and a compressive strength of only 15,650 psi at 78 F. An increase in temperature up to 212 F lowers this figure to only 6,150 psi. Under the same temperature change, the yield strength also shows a decrease from 3,550 psi to 1600 psi. Heavy impact loads will, therefore, cause some pounding out, wiping or shelling of the babbitt material.

With a thermal conductivity of 20.1 Btu per sq ft per degree F, babbitt is almost ten times as effective as fabric in removing frictional and radiated heat and is, therefore, less critical to periods of reduced water or lubrication supply. The coefficient of friction of babbitt varies greatly with local applications of coolant, lubricant, speed and loads, but wiping of babbitt is inevitable unless a good grease or oil film is maintained uniformly over the bearing surface. Regardless of the effectiveness of a grease lubricant, babbitt still needs plenty of water to remove generated heat from the roll neck. Conform-

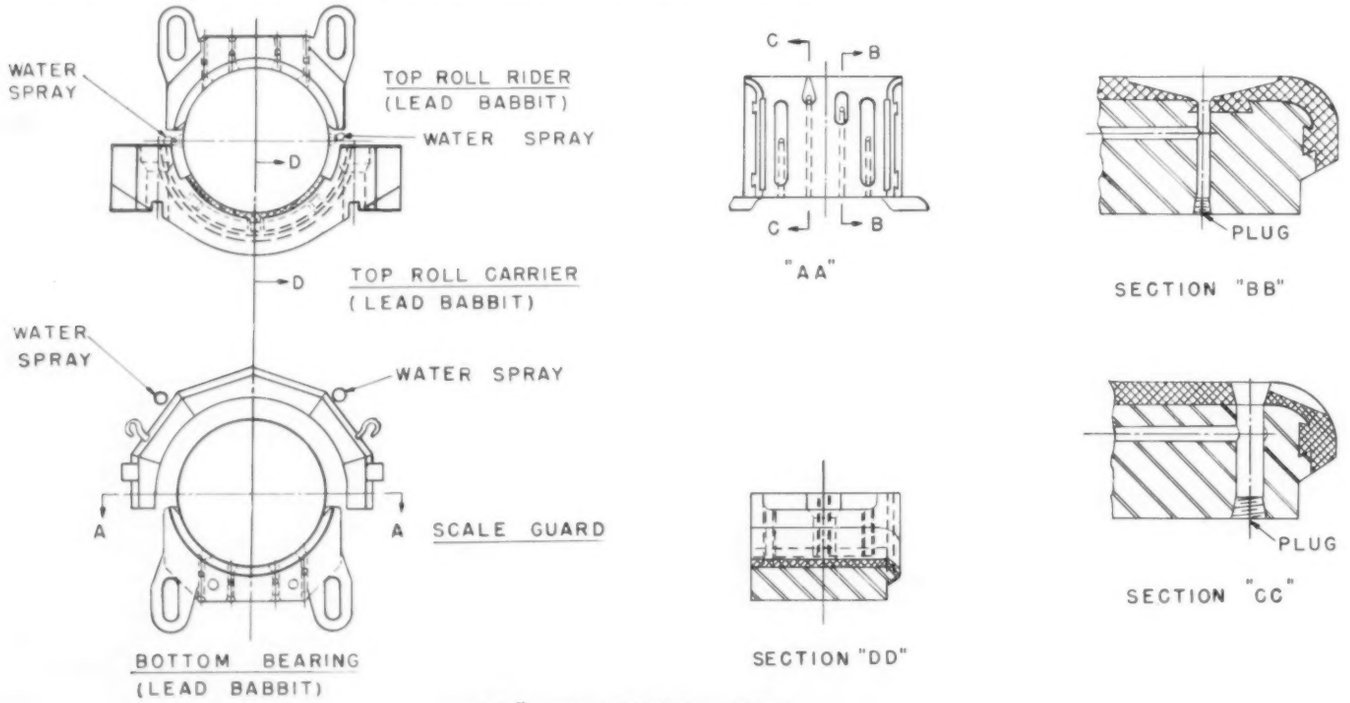


40" BLOOMING MILL NO.2

2-HIGH I-STAND

Figure 2 — An unusual design of fabric inserts in babbitt. Grease grooves are well out of the maximum pressure area. Loading is light at 1007 psi. With grease flow at 38.0 oz per hr and water flow of a calculated 36 gpm, this bearing has a normal life of 209,000 tons for the top and 140,000 tons for the bottom.

Figure 3 — An all lead babbitt bearing with unit loading of 2045 psi, grease flow of 14.4 oz per hr, water flow of a calculated 92 gpm on the top and 75 gpm on the bottom result in normal life of 1,000,000 tons. Note the provision for four grease inlets per bearing with the main grease grooves well out of the load zones.



40" SLABBING MILL

2 HIGH I- STAND

REVERSING MILL

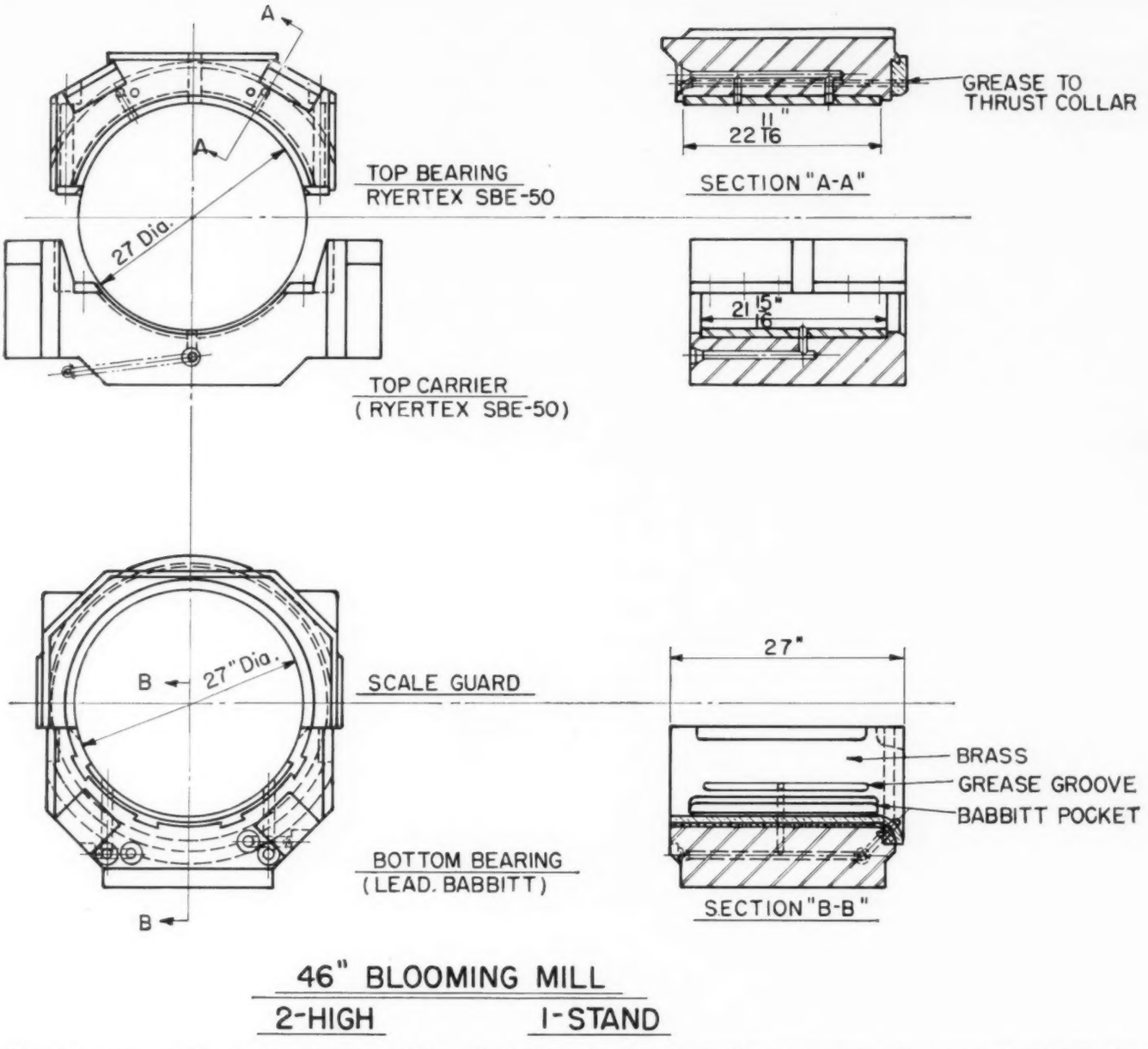


Figure 4 — Top bearing and carrier are babbitt. The bottom bearing is a lead babbitt pocket in a brass shell. Note the separation between the top fabric and thrust collar to minimize heat transfer to the fabric. With a loading of 1725 psi, grease flow of 19 oz per hr to each bearing (water flow is unknown), the bearing life is 1,000,000 tons for the top and an average of 71,000 for the bottom.

ability to variations in roll neck surface, embedability, and nonscoring properties are far better than fabric. In the consideration of replacement cost and available shop time, it must be remembered that babbitt bearings require removal of the bearing shell from the mill housing and subsequent shop work to insure good bondability to the bearing shell, proper tolerances and journal sizing.

In lubricating either the fabric or babbitt bearing, the lubricant, whether it be water, grease or oil, must be capable of reducing friction and carrying away heat. Since circulating oil systems found on mill drive motors are impractical in most rolling mill applications, the concern is primarily with water and grease. Where journal speeds are over 200 fpm, water will satisfactorily lubricate most fabric bearings, provided the water temperature is kept under 135 F. Above this temperature the water viscosity becomes so low that contact between neck and bearing can cause seizure. Grease applied to either bearing is only a means of carrying a lubricant. As such, it must maintain nonwashing properties and should be kept to a minimum to insure better heat conductivity and reduce frictional forces developed from the shearing action of the grease itself.

Dependable forced-feed metered grease systems, though initially more expensive, will pay later dividends. Grease application points through distributing grooves or grids are critical and should be kept out of the high load zone.

Water application must be zoned to keep the neck cool and will be most effective when applied to the neck journal for the longest period of time. The figures indicate various methods of good water application and point out the fact that in most mills there is a definite need for greater water supply.

However, regardless of choice of materials and design

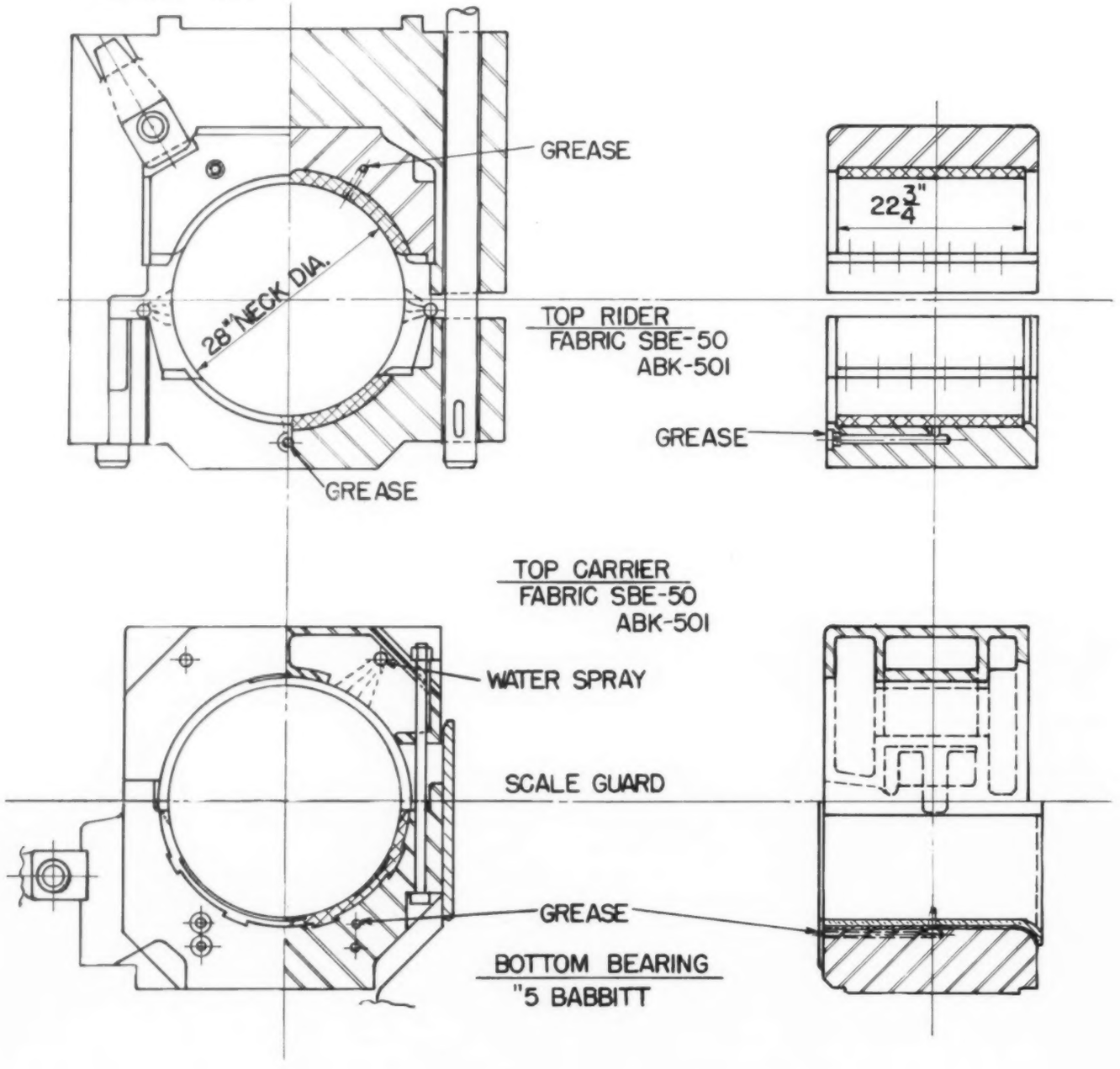
perfection, no plain bearing will be satisfactory without care and protection from operating and maintenance crews. A crew alert to the value of the primary mill bearing and its effect on good operating practices will insist that a few fundamentals of bearing care be maintained.

With the aid of the figures, the more salient features of operating and maintenance practices which have resulted in good and poor bearing performance are greatly simplified.

The heavy cast scale guard shown in Figures 7 and 8 for the bearings shown in Figures 5 and 6 have a fabric ring which forms a good scale-tight seal between the bearing shell and the roll. The weight of the scale cover riding down the inclined plane maintains constant pressure on the ring at all times.

From the figures which represent a good cross section of many installations, it is apparent that very few primary mill bearings have identical design, and no one design or type of material can be said to be the absolute best. However, disregarding local operating conditions, protection of any bearing can be improved by observ-

Figure 5 — Top bearing and carrier are fabric with grease inserted in the fabric. Bottom is babbitt with bronze grid inserts. Grease flow is 2.9 oz per hr and measured water flow is 384 gpm. Loading is high at 2181 psi and bearing life is 450,000 tons for the top and 209,000 tons for the bottom. This design of a heavy cast scale cover bolted to the bottom bearing will be shown in subsequent figures.



54" BLOOMING MILL
2 HIGH I STAND

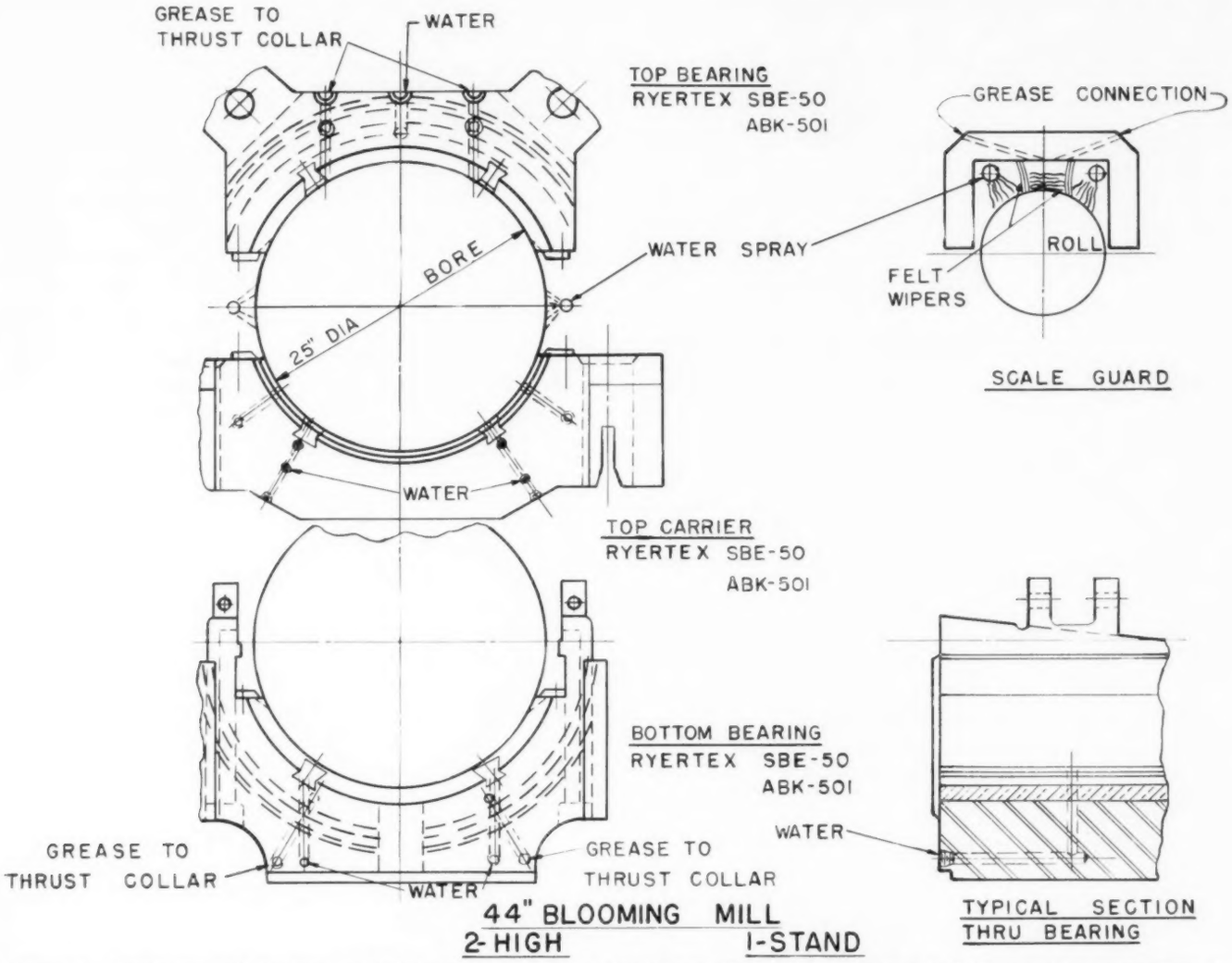


Figure 6 — Both top and bottom are fabric with a very high loading of 2854 psi. Grease flow is 8.16 oz per hr, water flow is 270 gpm on the top and 321 gpm measured flow on the bottom. The top bearing inserts are replaced after approximately 450,000 tons and $\frac{3}{8}$-in. wear, and the bottom fabrics are allowed $\frac{1}{2}$-in. wear before replacement. Bottom bearing life has averaged close to 1,500,000 tons. Note the unique method of grease application on the bottom roll.

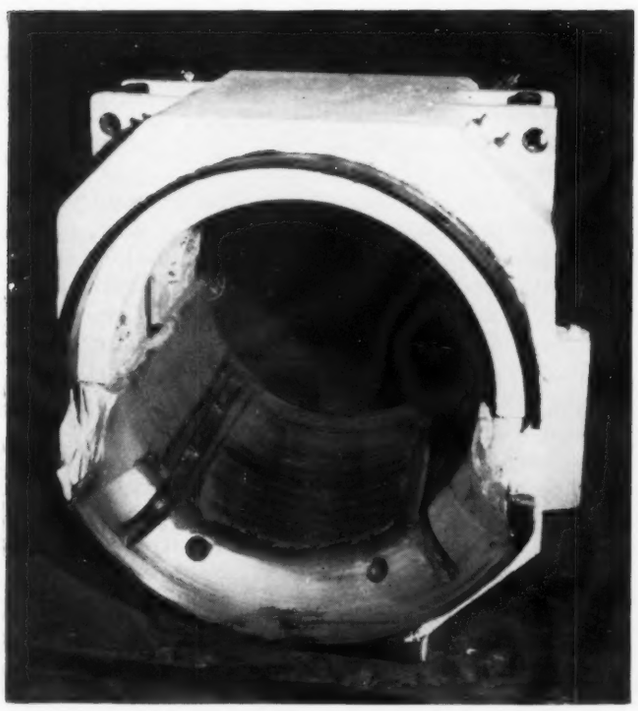
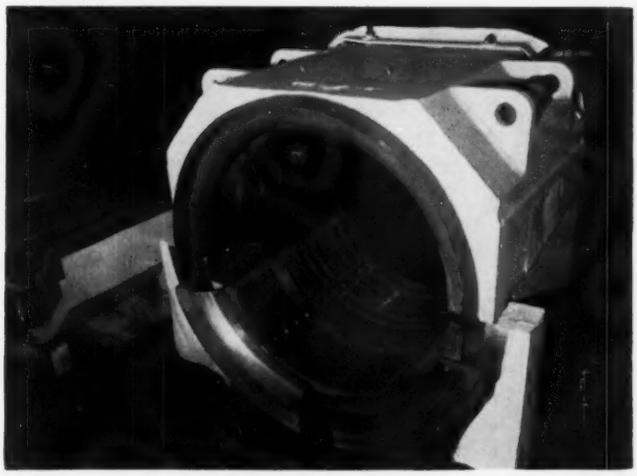


Figure 7 (left) — The only grease application to the fabric itself is through the grease groove in the top of the bearing. Water is applied through bronze grids on the top, bottom and carrier bearings. Roll necks are polished smooth before each rolling.

Figure 8 (below) — The heavy cast scale guard has a fabric ring which gives a good scale-tight seal between the bearing shell and the roll.



ing these basic fundamentals.

1. Roll necks must be polished.
2. Cooling water should be clean, cool and plentiful.
3. Grease source must be dependable and checked frequently.
4. Scale guards which form a tight seal are a must under conditions of heavy scale.
5. No bearing will last forever, and since it is expendable, a definite program with accurate records will aid in determining the bearing wear allowable to protect the roll neck and maintain predictable bearing wear.

Discussion

PRESENTED BY

H. R. KNUST, Assistant General Manager, Bethlehem Steel Co., Sparrows Point, Md.

WM. J. HILL, Project Engineer, Morgan Construction Co, Worcester, Mass.

GEORGE SACKERSON, Superintendent, Blooming Mills, Billet Mills, Rail Mills, Splice Bar and Tie Plate Shops, Bethlehem Steel Co., Lackawanna, N. Y.

CHARLES E. PRITCHARD, Superintendent of Mills, Alan Wood Steel Co., Conshohocken, Pa.

A. E. CICHELLI, Lubrication Engineer, Construction Engineering Dept., Bethlehem Steel Co., Bethlehem, Pa.

JEROME D. TULLOCH, Engineer, Chromium Corp. of America, Chicago, Ill.

H. R. Knust: The thought struck me that perhaps one reason Mr. Sackerson gets the life out of his bearings that he does is that here is an operating man who recognizes the maintenance problems and apparently is willing to go along and do something about it.

Wm. J. Hill: The author deserves thanks for the preparation and clear presentation of factual information concerning the quantity of water required for successful composition roll neck bearing performance. This is the first time that I have had an opportunity to hear discussed the life of different bearings in terms of tons rolled with the actual quantities of water and grease supplied to the respective bearings.

There is much controversy concerning the merit of grease introduced with the water. Many contend that the grease ultimately tends to block off the bearing water inlet passages. I would be much obliged if Mr. Sackerson would further enlighten us in regard to this possible objection.

George Sackerson: Whenever possible, we have endeavored to operate with as little grease as possible for fear of plugging the water passages. However, on reversing and slow speed mills, grease is absolutely essential in either type of bearing and therefore requires application which will be adequate for lubrication but not excessive for passage plugging.

It is highly improbable that grease can be properly metered directly into the parting between the roll neck and the bearing under terrific pressures to supply a smooth film without some excess grease collecting in the water groove and eventually plugging the groove.

Since this has been a frequent cause of bearing failures, we have gone to the felt or rubber wiper mounted in the scale cover which supplies a film and this so far has resulted in no plugging of the water passages.

Charles E. Pritchard: In summarizing the scope of coverage of this paper it is clearly indicated that local conditions introduce a known factor of control which must be recognized while adhering to the basic fundamentals which are found to coincide with satisfactory bearing service life of a primary mill.

While concurring with the desirability of applying clean, cool water as the cooling and lubricating media for bearing installations of this type, we as mill operators, seldom enjoy this utopian condition. Invariably we are faced with a composite of rather adverse conditions which generally reflect a seasonal change, thereby demanding planned operating and maintenance programs in keeping with existing conditions.

For the purpose of academic interest it might be stated that the usage of water on most composition bearing installations is not one of cooling only but rather also entails the acceptance of the theory that a lubricating film is formed by wedge action which tends to separate the rotating journal from the bearing interface. In defense of this theory, it can be stated that on the basis of past experience where water was used as a coolant only, bearing failure was soon evidenced. On the other hand successful bearing service life was realized on the same application whenever the proper steps were taken to ensure entry of the water in sufficient quantity to permit the formation of a lubricating film.

The suggested upper limit of 130 F water temperature is further substantiated whenever a study is made of the effects noted with increased temperature on the actual viscosity of the water. At the elevated temperature of 130 F the viscosity of water is found to be reduced to 5.0 millipoises as compared to 7.0 at 100 F and 8.0 at 90 F respectively. It can, therefore, be readily seen that the increased temperature could lower the viscosity to a point where film rupture could take place. Field study has indicated that this phenomena does take place in the nature of hot spots. A review of our own operating conditions would indicate that the critical period of bearing service life very closely parallels the season of high ambient and water temperature, all other conditions being equal.

A list of other factors which must be controlled in order to realize satisfactory bearing performance would entail provision of adequate filtration to remove suspended solids from the water, usage of magnetic type filters have been resorted to in our operations as an adjunct to usage of screens; control of the pH of the water, primarily to prevent pitting of the roll neck; treatment of the supply of water with appropriate chemicals to offset the deleterious effects of entrained oxygen, pitting of the roll necks also noted whenever this condition is encountered; proper application of grease to prevent plugging of water sprays and/or forming dams which retard heat emissivity from the work zone; installation of scale guards in such a manner as to ensure exclusion of scale at the bearing interface, usage of spring-loaded clamps have been resorted to as a means of preventing movement of the scale guard away from its proper seating on wedge type mountings during periods of heavy mill impact loading, and so forth.

Although usage of polishing agents has been incorporated as fillers in bearing material with a limited degree of success, it cannot be construed as a panacea of all ills and does not in any way reflect the need for emphasis being placed on the provision of polished roll necks. Likewise the addition of lubricating compounds as fillers has offered some measurable benefits but does not detract from the need for following the fundamentals of good bearing operation and maintenance as outlined so ably in this paper.

A. E. Cichelli: The author stated roll adjustment techniques and roll changes had a very great impact on the life of the bearing. We appreciate this comment and believe his personal success on long bearing life is largely due to this realization.

I wonder if I might offer some random comments from a few notes I jotted down during the paper presentation.

I heard mention of water and grease on fabric bearings. Usually the thinking we follow is that grease seems to be helpful, perhaps mandatory for good life in a reversing mill.

When a roll revolves in a plain bearing, starting from a standing position, there is always metal to metal contact, or roll-to-bearing contact; there is no film in between them. There is no film therefore when the relative positions of roll and bearing are static at the point of reversals. Consequently the presence of a lubricant, like grease, will facilitate the start of rotation and hence the film itself.

There is another point to consider in connection with water-lubricated bearings. How much of the water represents cooling and how much lubrication. If you think back to some of the water figures that Mr. Sackerson gave, you will recall they ranged from a low of about 30 gpm to something like 300. Wherever bearings are capable of operating for extended periods at these low water flows, it is very unlikely failure came about for lack of a water wedge, proving that the amount of water needed for lubrication can be quite small. But he did point out that his best performances were from fabric bearings that were supplied with large volumes of water, implying that a large percentage of this extra volume was for cooling purposes primarily. The life of these bearings then is dependent not just on the lubricating (or hydrodynamic) qualities of water, but primarily upon its cooling capabilities. But why does cooling water do so much good? Applying the theory of hydrodynamic lubrication, with water as the fluid in question, we realize its viscosity is a paramount factor. Though water viscosity changes comparatively little with temperature, as say, compared with oil, which changes at a great rate, it is nevertheless important to realize its viscosity is very low to start with at room temperature. It is 1 centipoise at 70 F, 0.68 centipoise at 100 F and 0.43 centipoise at 50 F. For comparison, SAE 30 oil at 100 F has a viscosity of 300 centipoises. Therefore, when temperatures of about 100 F to 135 F are mentioned, a very, very low viscosity actually exists.

But in the design of a plain bearing, there are other important considerations, such as load, speed and clearance. With all things remaining equal, the lower viscosity fluid will generate a lower film thickness of fluid supporting the rotating shaft. In the case of a fabric bearing and water of say 135 F it becomes obvious the film thickness will be extremely small—and very likely, the roll neck will seat itself until it has established this working clearance. The latter may be too small for satisfactory long operation without gradual wear and for that reason, colder water which establishes a safer, thicker film thickness is desired. And this evidently comes about by providing large volumes of roll neck cooling water, thereby tending to keep the film interface temperature down.

Calculations show that for rod mills with 9-in. necks, 100 F water can float a neck, but only under very close operating clearances—such as radial clearances between 0.0005 and 0.0018 in. with corresponding film thicknesses of 0.0001 to 0.00005 in. Note that with the larger clearance the journal actually comes closer to the bearing surface. Though actual clearances and film thicknesses may differ from these values, certainly one can reason from them that conditions for hydrodynamic lubrication are so limited that practically speaking, only under the very best conditions, does it exist. The tendency will always be for the journal to seat itself into the bearing until the radial clearance has been made small enough to permit the water to float the roll. Only when the necks are in perfect condition and the water is cold, can best life be realized.

I do not think it was mentioned, but some of the fabric bearings today have molybdenum disulphide as a filler. And in some of our installations where molybdenum disulphide has been used as a filler, the life of the bearing has been extended. We conclude from this that since molybdenum disulphide does not enter into any wedge action, extended bearing life was due to the fact that we were experiencing boundary lubrication much of the time. Molybdenum disulphide could only have come into play under boundary conditions. If molybdenum disulphide had done no good at all, then we would have concluded the hydrodynamic effect of the water was adequate in supporting the load. Whenever a solid lubricant such as MoS_2 extends bearing life, boundary conditions must prevail much of the time. That seems to be the case with many fabric bearing installations. Actually, the mixed film concept seems to apply best.

Grooving—Comment was made that a groove in the load zone is undesirable. That has certainly been taught to us as far back as we can recall. I believe, however, that that principle is primarily for oil-lubricated bearings. The slab mill bearing that was shown with the groove in the radial near the thrust collar, since 1938, has been consistently giving us bearing life of a million tons. The groove in that area was added at the time that the entire bearing was redesigned in 1938. Prior to that we were only enjoying 200,000 tons. This bearing was originally a bronze and babbitt combination with grooves in the bronze. Now it is an all-babbitt bearing with an additional groove in the center. The theory behind the stated principle, "a groove must not be placed in the load zone," is that the groove tends to break up the hydrodynamic film. But in grease lubrication, hydrodynamic lubrication occurs only for a short period of time and that period of time is the time that the grease is actually flowing into the load area. This has been established in work done at the Franklin Institute in Philadelphia. In between the intervals of

lubrication, that is in between the times the grease is fed into the load area, grease is lubricating the bearing not because of a hydrodynamic wedge that is formed, but because of its boundary properties. Consequently, the groove in the load zone does not destroy any wedge because there is none there to destroy. Actually, the extra groove served in this particular case to supply grease to a part of the bearing, that was consistently giving trouble, down near the thrust collar. Incidentally, the extra feed increased the grease by 25 per cent, a fact which is certainly of some importance.

Now I am not going to advocate that you leave here and cut grooves into all bearing load zones; but I know what happened in this case, and I would not hesitate should a similar problem develop in a grease lubricated bearing, to add a groove in a load zone, recognizing of course that the load per square inch is not allowed to increase too drastically by this action.

What is the effect of the lubricant itself? Mr. Sackerson's presented us with quite a range of ounces of grease per hour. I do not recall whether frequency was mentioned. But one can readily realize how important this factor is. A definite volume per hour frequently applied in small amounts, is far better than the same quantity applied in larger increments, but over longer intervals of time. This principle pre-supposes the same grease is used. Generally speaking, a fabric bearing requires very little grease, and the authors figures brought that out. As for metallic bearings, we feel that the frequency and quantity depends on the nature of the lubricant. We learned in the study referred to by the author that the nature of the lubricant does not affect seriously the over-all tonnage as long as application practice is modified to suit the lubricant. Certain type lubricants will adhere better, so quantity and frequency of application are adjusted accordingly. Other type lubricants, that do not adhere as well, will require an increased frequency of application for the same quantity.

Our experience shows that we have been able to achieve a million tons of bearing life with calcium soap greases, lithium soap greases, etc., with and without graphite or extreme pressure agents. Therefore, the nature of the grease, though important, does not seem to affect the life of the bearing as long as practice is modified to suit. This includes the method of application which plays a large part in the economics of application and bearing performance. Understanding the system that applies the lubricant and getting the most out of it cannot be overlooked. Systems are different, and have to be handled differently. This item we believe to be another important factor and contributor to the life of a bearing.

I might add that when bearing life is extended simultaneously with a reduction in lubricant cost, the ultimate has been reached. Apparently, roll neck spray lubrication, which we have successfully applied on a 40-in. blooming mill is one of the newer techniques that may well lead us in that direction.

Jerome D. Tulloch: We were happy to hear one comment made by Mr. Sackerson and that was to the effect that you had to have smooth necks. Our company has advocated that for years.

Has any study been made on stray currents and their effect on roll necks? We have heard a lot about lubrication and everything else, but we seem to find that there is some indication that stray currents bother the roll necks and cause a cavitation which results in a rough surface on the necks, causing excessive wear on the bearings.

George Sackerson: If we have any process of electrolysis caused by stray currents which in turn causes pitting or cavitation of the necks, I am not familiar with it. It certainly does seem feasible that there might be some stray currents when you consider the location and design of a blooming mill in juxtaposition to a high horsepower mill drive motor.

We have never tried chromium roll necks, by the way. ▲

1958 AISE

SPRING CONFERENCE

April 21, 22, 23

The Dinkler-Tutwiler Hotel

Birmingham, Ala.

In establishing a good power layout, proper balance must be obtained between cost and reliability. . . . planning should be aimed at reducing maintenance problems, insuring safety of personnel, and providing access to components.

Power layouts in steel mills

by A. J. MOSSO, Vice President, Auburn & Associates, Inc., Pittsburgh, Pa.

A-C and d-c power distribution in steel mills; the selection of equipment such as switchgear, transformers, motors, generators, rectifiers, etc; the theoretical calculations required for proper equipment selection, and the economics involved would require many papers. Therefore, the intent of this paper is to discuss the practical aspects involved in the physical arrangement of this equipment and the approach to the problem of making installation layouts required for field erection of both the equipment and the interconnecting ducts, conduit, cable, wire and bus.

It would, however, be impossible to ignore the type of equipment used and the basic single line diagrams, since these affect the physical layout of the equipment and the maze of interconnecting cables; nor can one ignore the fact that the electrical power system extends its tentacles into every crevice of a steel mill from end to end and from the peak of the roof gable to the depth of subterranean looping pits.

NATURE AND SIZE OF THE LOADS

In addition to covering large areas, electrical power consumption in a steel mill is very large and is subject to heavy swings at frequent intervals. As the demand for production increases and the speed of mills is pushed upward to meet this demand, the size of the loads continues to increase.

As the size of the load increases, the power systems and the control of it increases in complexity. In a modern mill the power system now covers almost the entire field of electrical application. High voltage overhead power lines, outdoor substations, generating stations, underground duct systems, large transformers, a-c and d-c motors, motor-generator sets, all types of rectifiers, electronic equipment and automation are all a part of a steel mill electrical distribution system.

LOADS AND UTILIZATION VOLTAGES

Table I indicates the load requirements of a typical integrated steel mill and in which part of the mill the loads are concentrated.

The average load is important in proper selection of cable sizes. Note that this is quite different from the selection of transformers, generators, etc., where the selection is made on demand loads and potential requirement of the future. In a typical mill the 15-min demand is 50 per cent over the average, the 1-hr demand is 32 per cent over the average and the 8-hr demand is 22 per cent over the average.

Table II lists the voltages that one might encounter in making a power layout for a steel mill.

TABLE I

Mill	Connected load, Kva	(One-hour) approx. average load, Kva
Raw material handling	1000	400
Coke plant	2000	800
Blast furnace	1500	700
Open hearth	2000	700
Blooming mill	9000–16000	3000–6000
Slabbing mill	7000–13000	2800–5500
Bar and billet mill	12000–16000	4000–6000
Hot strip mill	30000–50000	12000–18000
Sheet mill	17000	7000
Tin mill	27000	10000
Temper mill	3500	1200
Process lines	10000	2000
Storage and shipping	2000	600
Misc services	7000	5500

TABLE II
Utilization Voltages

System voltage	Frequency, cycles	Application
18 to 30	d-c	Process lines
110	25–60	Control and lighting
220	25–60	Control of smaller motors
250	d-c	Auxiliary mill motors and switchgear control
440	26–60	A-c motors up to 500 hp
600 to 700	d-c	Main mill drives
2300	25–60	A-c motors up to 2000 hp
4160	25–60	A-c motor—above 1000 hp
6900	25–60	A-c motor—above 1000 hp
11500	25–60	A-c motor—above 2000 hp
13800	60	A-c motor—above 2000 hp and general plant power distribution
23000	60	Overhead power distribution and purchased power
34500	60	Overhead power distribution and purchased power
46000	60	Overhead power distribution and purchased power
69000	60	Overhead power distribution and purchased power
132000	60	Purchased power only

Obviously, this table covers practically all the voltages ordinarily used anywhere. Present day trends, if we do not consider special process voltages, are to use 110 volts for control, 250 volts for small d-c motors, 440 volts for small a-c motors, 600 volts for large d-c mill motors, 2300 volts for medium size a-c motors and either 6900 or 13800 volts for power distribution and large motors. Voltages above 13800 are used for power distribution and are utilized according to the size of the mill.

One more general aspect of a power system should be reviewed before the making of layouts for a new mill or the expansion of an old one are discussed; namely, the power system that one inherits when an old mill is expanded. Figure 1 shows a typical single line diagram of a large existing mill.

Note that both 25- and 60-cycle power is used and that a variety of voltages are utilized to complete the distribution system. Certain standards and practices of the engineers and operators grew up with the system. In an expansion of an existing mill, it is always wise before beginning layouts to familiarize oneself with these standards. In an entirely new mill, certain electrical standards are transferred from places of previous employment. Mill engineers are reluctant to modify these practices.

BASIC PRINCIPLES OF A GOOD POWER LAYOUT

The previous comments have reviewed, in a general manner, the loads with which one must contend and the potentials at which these loads are transmitted. Now assume that an expansion program is planned and you are responsible for the design and layout of the electrical system. Certain basic considerations should be kept in mind at all times in making a power layout. These are summarized as follows:

1. Proper balance between cost and reliability must be maintained. Blast furnaces, boiler house and other heat processes require continuity of service if severe damage is to be avoided. Productive output of a steel mill is so large in dollar volume by comparison to electrical system costs, that in many cases duplicate supplies through duplicate cables are a wise and economically sound investment.
2. Maintenance problems can be reduced by good planning and proper access to equipment and distribution system components.
3. The rugged service to which steel mills subject a distribution system, both mechanically and electrically, requires both good materials and sound design. In the selection of wire, bus, cable, conduits, etc., the standard practice is to be liberal.
4. Safety of personnel should be of prime consideration and in most mills, new construction is planned to be as safe as feasible.
5. Co-ordination between mechanical, foundation, piping and electrical to permit the best electrical installation is essential to a good job.
6. The electrical system should be designed to permit ease of installation by the contractor doing the field work.
7. Conditions existing at any given site will influence the selection of conduit, cable, bus and fittings required for installation.
8. The layouts should proceed in an organized, orderly fashion and materials with long delivery should be put on order as soon as possible.

POWER TO NEW MILL

While we have been thinking about generalities, let us assume that an order has been placed with a mill builder for the required mill. The mill builder in turn has prepared a motor list for the electrical manufacturer who submits an electrical proposal covering both the main drive and mill auxiliaries with its associated control. Preliminary outlines of major electrical equipment will soon be available, we hope, and the time to proceed with the layouts is at hand.

The first problem would be to get power from either a substation or the generating station or perhaps, by tying into an existing distribution loop, addition of a new substation or an additional generator. There are several ways in which this can be done, namely, overhead power line on poles, armored cable supported on poles or buildings, or an underground duct system.

Of the three methods, the underground duct system is by far the most popular, and after all consideration is generally the most desirable method of power distribution. If the loads to be serviced are concentrated and large; a duct system offers the advantages of greater reliability, the least possibility of being in the way of future expansion, and all the flexibility of either of the other two methods if the design is properly made.

If the number of cable runs is limited to a small number and the routing is such that existing buildings are available for support, the armored cable offers both reliability and some economy over the duct system.

If the load is isolated and the power must be carried over a long distance, the overhead power line may be necessary for economic reasons. This method offers the greatest economy in initial cost but the least reliability. It also requires much more maintenance than either of the other two methods. Maintenance can be reduced by using insulators having a rating at least one standard step higher than the line voltage.

If the voltage of the distribution system exceeds 15 kv, then economic considerations and maintenance of an underground system because it becomes specialized, makes an overhead system a must.

Since the productive output of even a medium sized mill could approach $100,000 per hr, continuity of service is very important. Moreover, maintenance of overhead lines may get very expensive. Therefore, if the voltage is 15 kv or less, the underground system which offers both advantages of low maintenance and excellent continuity of service should be used except in special cases. The cost of the underground system considered over its life span is no more than other methods which offer less advantages.

GROUNDING SYSTEM

The second consideration in making a layout for a mill is the grounding system. The engineering associated with a grounding system is done on an empirical basis; that is, not by a mathematical formula. New theories on electrolysis have been advanced in the past 7 or 8 years. These have yet to prove their value

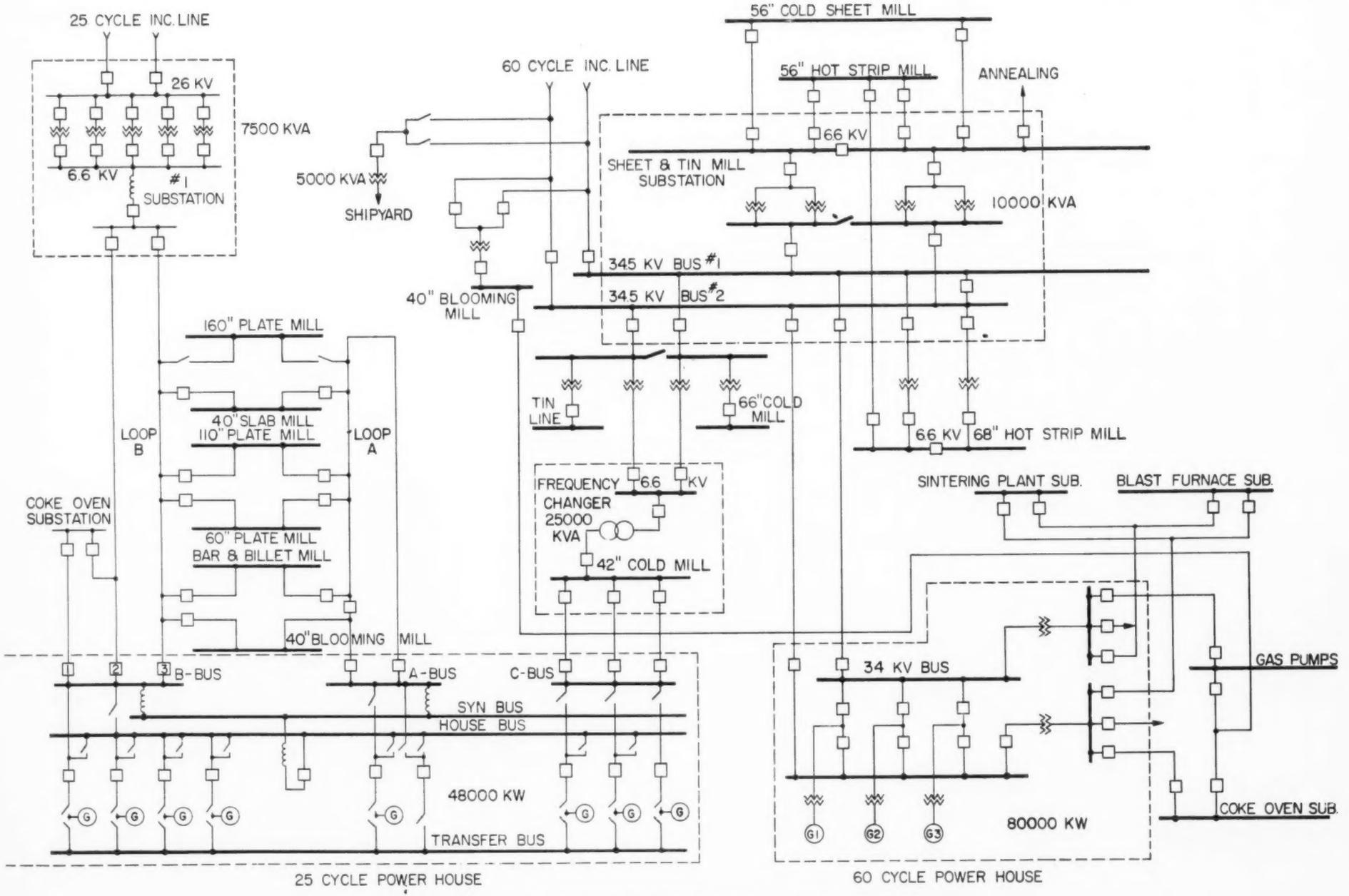


Figure 1 — Single line diagram for power distribution in existing steel mill.

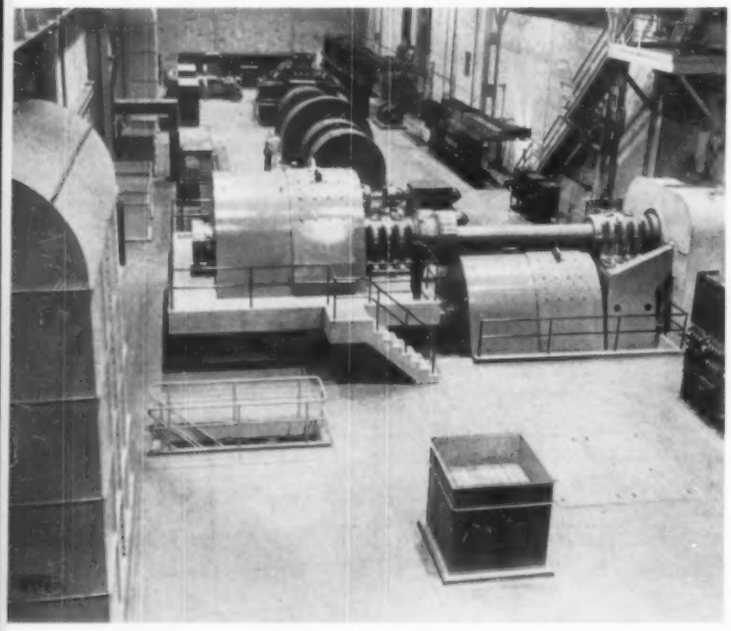
in service over any long period of time. These theories require insulated cable and bus which add considerably to the cost of a grounding system. It may be some time before the additional cost of an elaborate, insulated grounding system can justify itself by savings resulting from a reduction of galvanic action on underground pipe. There is hardly a mill in operation which does not have some d-c power cables grounded. These uncleared grounds cause more damage than the current in the plant grounding system. Most mills prefer the bare cable ground system.

In preparing a grounding system, a loop is installed around the building with diagonal ties to permit the grounding system to function even if a cable were to be sheared. It is sufficient to ground every other column. This loop is used as the main grounding circuit and the motors and other equipment is connected thereto. The grounding wells, of which there are many varieties, should be installed below water level.

The National Electric Code recommends that d-c equipment be grounded by a cable not smaller than the power cables feeding the equipment. This code also recommends minimum cable sizes for a-c equipment grounding. However, in a steel mill, the loop is generally 500 MCM cable and several standard sizes are chosen to be used depending on the equipment. Usually No. 4, 2/0 and 500 MCM will cover all cases. The 13.8-kv equipment should not be grounded with less than 2/0 cable to avoid fusion of the cable under fault condition. Large motors require several ground connections to the frame.

Some mills ground exposed conduit runs although this practice is not so prevalent since it is generally unnecessary to do so. The sheath of high voltage lead covered cable should be ground for safety reasons and is usually done at the man holes. If single conductor cable is used, a layout of the duct system should be submitted to the cable supplier so that an expert study can be made of the grounding requirements. The copper strap connection to the lead sheath should be sweated or completely covered with lead to avoid electrolysis and eventual pitting of the lead sheath on the cable.

Figure 2 — View shows a typical slab mill motor room.



MOTOR ROOM

Approximately 60 to 70 per cent of the work in making mill electrical power layout is in the motor room. The motor room size and the arrangement of equipment are the first requirements. Since almost the entire layout depends on a good arrangement, this job requires the most experience and knowledge. Motor room size and equipment arrangement is generally required far in advance of certified outlines. Approximate dimensions of electrical equipment should be obtained from the manufacture or the job should be done by an engineer of considerable experience. Practically all poor electrical layouts can be traced to an equipment arrangement made by people who lacked the experience to do the motor room layout properly.

The subject of motor room arrangements would in itself require a complete paper. However, let us look at some of the practical considerations required for a good arrangement.

1. The main drive motor or motors are, of course, positioned the mill location and the motor room is, in a sense, built around the main drive.
2. Variable voltage motor-generator set or rectifiers should be located as near to the main drive as feasible.
3. Main control panels should be between or near the motor and motor-generator set.
4. Other motor-generator sets should be located in the direction of the equipment which they serve.
5. Control panels for auxiliary equipment, both a-c and d-c should be located in the direction of the motor which they control.
6. The panel "line-up" should be in the same sequence as the physical arrangement of the motor which they control. In many cases it will be necessary to set up several groups of panels to obtain the most desirable location.
7. Motor rooms require basements even though the chief engineer does not think so.
8. Space should be provided for setting equipment on the floor for maintenance.
9. A crane is highly desirable in motor rooms of large mills.
10. Hatchways to permit equipment access to basement should be provided.
11. Equipment access openings of adequate size should be provided.
12. Stairways to basement and man escape ways should be provided.
13. The ventilating and air cleaning system for the rotating equipment should be worked into the arrangement.

Figure 2 shows the arrangement of a typical slabbing mill. Note that the considerations mentioned above are included in this arrangement.

Space does not permit a complete discussion of motor ventilating schemes. However, certain basic considerations should be pointed out. If the ventilating system is to be a non-recirculating one, it is advisable to use an updraft scheme which will bring cleaned air into the basement. After cooling the machinery, the air is exhausted to the mill or through roof exhaust systems.

If the ventilating system is a recirculating one or a partial recirculating one, the cleaned air should be brought into the motor room at mill floor level and a down draft scheme used.

Of the two systems, the non-recirculating one is by far the most popular.

A third scheme is to use a closed system (used mostly on large electrical drives) in which the air is cooled by water to air-heat exchangers. This system is the most costly to maintain and adds the danger of flooding the motor pits when a plumbing failure occurs. This scheme is not often used in mills but appears quite frequently in wind tunnels where the horsepower of the drives varies between 15,000 and 85,000 hp.

The volume of cooling air for a mill motor room is very large, in the order of 500,000 cfm for moderate mills. Certain empirical rules have come into practice which may be of help to engineers in the steel industry.

Approximately 125 cfm is required to dissipate one kw loss. Approximately 20 per cent is added to this quantity to cover air losses in the system. Air cleaning equipment should have an excess capacity of 25 per cent to cover loss of efficiency if equipment is not kept absolutely clean. Velocities of more than 400 fpm are not desirable through air cleaning equipment. No less than 10 ft should be provided between the filter and the fans or between the filters and any restricted inlet. This is, of course, to keep air from concentrating its run through only a small section of the filters and to prevent turbulence.

Velocities of more than 1000 fpm in ducts or tunnels is not desirable. However, velocities as high as 2000 fpm must, on occasion, be used. If this is the case, sheet metal ducts should be properly reinforced to avoid excessive vibrations or noise.

Booster or monitoring fans should be provided at major equipment. If the motor room is long and narrow, a system in the center of the room or two systems, one at each end of the room should be used.

Changing motor speeds can affect a ventilating system considerably and should be considered in the design. Dead air spaces should be avoided even if ducts must be provided to get air to these spaces. Louvres or baffles, both in motor pits and in the room, should be provided to permit adjustment of air flow with the mill in operation.

CONDUIT AND CABLE SCHEDULES

After the motor room layout is finalized, the conduit and cable schedules should be written. Here again, "*know how*" is vital in keeping your construction schedules. By the very nature of the job, the last information received from the electrical manufacturer must be the wiring diagrams. If you do not have available, people who can write accurate and reasonably final conduit and cable lists from the electrical manufacturer's proposal, you can set your installation schedule back by at least six months. A delay of this length in light of the productive output of a modern mill is costly indeed.

Conduit and cable schedules should provide the following information:

A. *Conduit*
   1. Conduit number.
   2. Point of origin.
   3. Destination.
   4. Routing.
   5. Purpose of the conduit.
   6. Size, length and type of conduit.

B. *Cable*
   1. Quantity of cables in a given conduit.
   2. Number of conductors per cable.
   3. Cable size.
   4. Type of insulation.
   5. Voltage.
   6. Length.
   7. Color coding of control wires.
   8. Wiring diagram reference on which the wire appears in the wiring scheme.

After the schedules are written, control stations or operating pulpits should be located, preferably, by the mill operators.

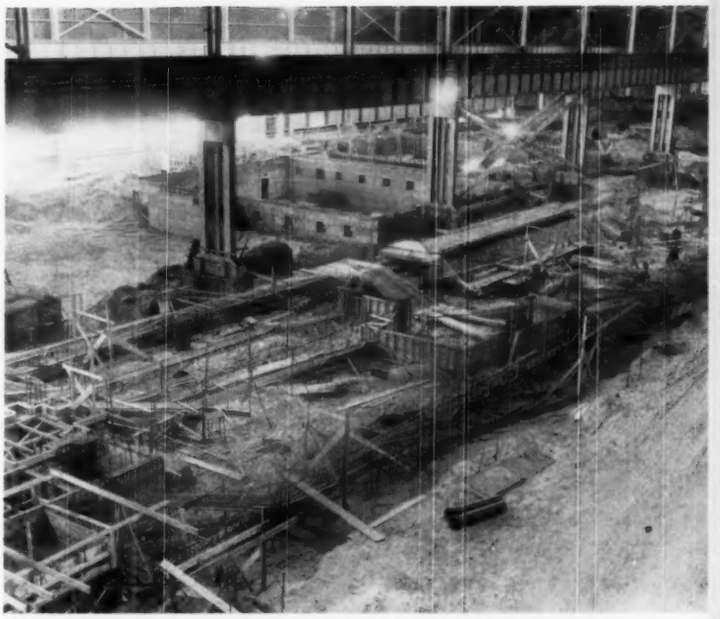


Figure 3 — Conduit layout is essentially a routing problem.

Figure 4 — Mill experience is essential to develop best conduit layouts.

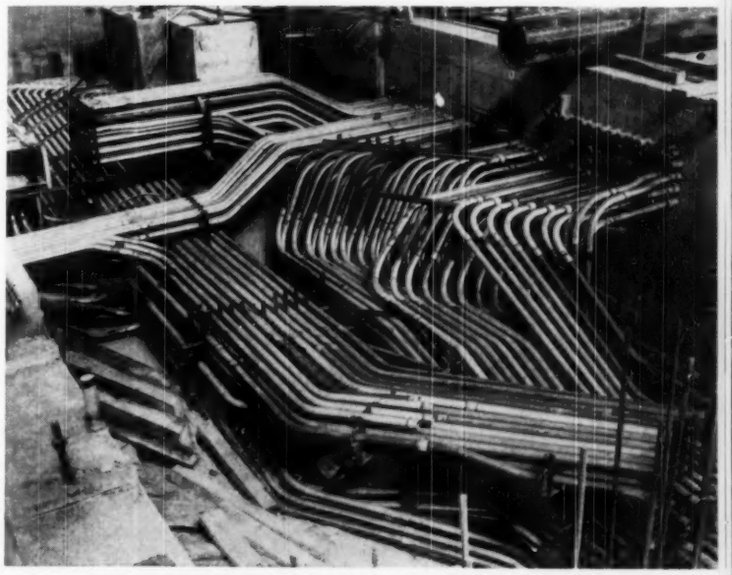
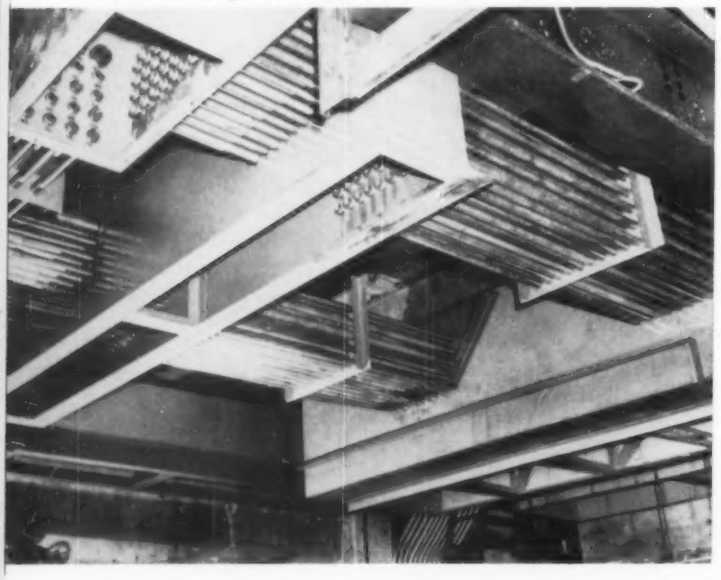


Figure 5 — Cable trays are being used more widely in motor rooms.

CONDUIT LAYOUTS

The conduit layout for a mill area is primarily a routing problem. After the foundation drawings are completed, conduits are spotted at the motors, control stations or other electrical equipment. These conduits are then grouped and routed to the motor room. Sometimes a tunnel with cable trays can be used in lieu of conduit. This scheme provides some economy, but also creates a fire hazard. The conduit layout of the mill areas is relatively simple. Approximately 20 to 25 per cent spare conduit should be provided for embedded runs. Figures 3 and 4 show typical conduit layouts in mill areas.

Figure 6 — Conduit runs for slabbing mill motor room are here hung on basement ceiling.



The motor room conduit layout is much more complicated. There is a growing tendency to use cable trays in the motor room. Figure 5 shows a neat arrangement of cable trays in a control room of a process line. Figure 6 shows conduit runs hung on the basement ceiling of a slab mill motor room. These two figures indicate clearly that a cable tray layout is less expensive both in material and installation costs. On the other hand the tray layout could also cause an expensive fire and damage to a large number of cables when only one cable fails. Figure 6 shows several pull boxes. These are interesting since they seem to be of adequate size. The cardinal sin of an inexperienced layout man is to make pull boxes too small. The boxes should always provide adequate room for bending the largest size cable with a radius of at least 10 times its diameter and to permit the electrician to work the cables through the box with ease. The conduit supports in Figure 6 are interesting. Note that there are sheet metal plates drilled to take the conduit runs.

Exposed conduit can be black enameled but all embedded conduit should be galvanized. Non-metallic bushings give the advantage of reducing cable failure at conduit termination points. There use is growing in popularity over the metal bushing.

A discussion of the many types of cable and the selection of the most suitable type would take several papers. However, some practical consideration in sizing cable and the selection of the insulation should be considered a part of this discussion.

For 15-kv service, paper insulated, lead covered, compact sector cable having a diameter of less than $2\frac{1}{2}$ in. for 3/C, 500 MCM is by far the most common choice since it will fit into a 4-in. conduit. In special applications an additional neoprene jacket is required on the cable.

For 6900- and 2300-volt service, varnished cambric lead covered cable is the popular choice.

For 1000-volt (or less) service, a synthetic rubber insulated cable known as "RHRW" is the favorite. Only a few years ago varnished cambric lead covered cable for both power and control was used almost exclusively in steel mills. However, the development of new plastics makes this practice almost obsolete because of its cost. Single conductor cable is most frequently used for the large sizes and multi-conductor color coded cable is used for control circuits.

This selection of cable sizes for steel mill auxiliary drives is made simple by tabulations similar to Tables III and IV. Cable size selection indicated in this table have been proven satisfactory over a long period of use in steel mills.

These cable sizes are approximately 25 per cent above NEC requirements. However, the severe service to which cable and wire is put in a steel mill justifies these sizes.

All cable used in a steel mill should be stranded and preferably with finer stranding than standard. Vibrations caused by movement of heavy machinery have a tendency to cause cable of large strands to break. This is usually a very difficult fault to locate especially in control cable. Usually a 19/25 stranded cable, 19 strands of No. 25 wire, is used for control circuits. Most steel mill engineers use 1/C, 3/C, 5/C, 9/C and 12/C cable for control. Cable should be bought

TABLE III
Cable Sizes with Relation to Motor hp

Hp	440-v, 3ϕ alternating current	230-v, d-c series		230-v, d-c compound		
		Reversing	Non-reversing	Reversing	Non-reversing dynamic braking	Non-reversing
½ to 3	3-No. 19/25	4-No. 19/25	2-No. 19/25	4-No. 19/25 2-No. 19/25	3-No. 19/25 2-No. 19/25	2-No. 19/25 2-No. 19/25
5	3-No. 19/22	4-No. 8	2-No. 8	4-No. 8 2-No. 19/22	3-No. 8 2-No. 19/22	2-No. 8 2-No. 19/22
7½	3-No. 19/22	4-No. 6	2-No. 6	4-No. 6 2-No. 19/22	3-No. 6 2-No. 19/22	2-No. 6 2-No. 19/22
10	3-No. 19/22	4-No. 4	2-No. 4	4-No. 4 2-No. 19/22	3-No. 4 2-No. 19/22	2-No. 4 2-No. 19/22
15	3-No. 8	4-No. 2	2-No. 2	4-No. 2 2-No. 19/22	3-No. 2 2-No. 19/22	2-No. 2 2-No. 19/22
20	3-No. 6	4-No. 1/0	2-No. 1/0	4-No. 1/0 2-No. 19/22	3-No. 1/0 2-No. 19/22	2-No. 1/0 2-No. 19/22
25	3-No. 6	4-No. 2/0	2-No. 2/0	4-No. 2/0 2-No. 19/22	3-No. 2/0 2-No. 19/22	2-No. 2/0 2-No. 19/22
30	3-No. 4	4-No. 4/0	2-No. 4/0	4-No. 4/0 2-No. 19/22	3-No. 4/0 2-No. 19/22	2-No. 4/0 2-No. 19/22
35	3-No. 4	4-No. 4/0	2-No. 4/0	4-No. 4/0 2-No. 19/22	3-No. 4/0 2-No. 19/22	2-No. 4/0 2-No. 19/22
40	3-No. 2	4-No. 4/0	2-No. 4/0	4-No. 4/0 2-No. 19/22	3-No. 4/0 2-No. 19/22	2-No. 4/0 2-No. 19/22
50	3-No. 2	4-350 MCM	2-350 MCM	4-350 MCM 2-No. 19/22	3-350 MCM 2-No. 19/22	2-350 MCM 2-No. 19/22
60	3-No. 1	4-500 MCM	2-500 MCM	4-500 MCM 2-No. 19/22	3-500 MCM 2-No. 19/22	2-500 MCM 2-No. 19/22
75	3-No. 1/0	4-500 MCM	2-500 MCM	4-500 MCM 2-No. 19/22	3-500 MCM 2-No. 19/22	2-500 MCM 2-No. 19/22
100	3-No. 4/0	4-1000 MCM	2-1000 MCM	4-1000 MCM 2-No. 19/22	3-1000 MCM 2-No. 19/22	2-1000 MCM 2-No. 19/22
125	3-4/0 MCM	4-1000 MCM	2-1000 MCM	4-1000 MCM 2-No. 8	3-1000 MCM 2-No. 8	2-1000 MCM 2-No. 8
150	3-250 MCM	8-500 MCM	4-500 MCM	8-500 MCM 2-No. 8	6-500 MCM 2-No. 8	4-500 MCM 2-No. 8
200	3-500 MCM	12-500 MCM	6-500 MCM	...	...	...
Alternate Cable Sizes for 80-In. Hot Strip Mill Auxiliary Drives						
100	...	8-350 MCM	4-350 MCM	8-350 MCM 2-No. 8	6-350 MCM 2-No. 8	4-350 MCM 2-No. 8
150	...	8-500 MCM	4-500 MCM	8-500 MCM 2-No. 8	6-500 MCM 2-No. 8	4-500 MCM 2-No. 8
200	...	12-500 MCM	6-500 MCM	12-500 MCM 2-No. 8	9-500 MCM 2-No. 8	6-500 MCM 2-No. 8

Note—For d-c motors 10 hp and larger, shunt field leads and main leads should be run in separate conduits. When armature and field leads are run in the same conduit, cable should be multiple type with only one cable per conduit. For d-c motors, cables larger than 2/0 should be single conductors.

with several spare wires to permit revamping control circuits. Since the modern plastics can be obtained which are both water and acid resistant, it is no longer necessary to worry about the cable getting wet. This point is brought out since some of the engineers from the old school still worry about condensation in conduits.

BUS LAYOUTS

Prefabricated enclosed bus has an excellent application for low voltage entrance feeders or for connections between an outdoor transformer and low voltage switchgear.

However, power bus in a steel mill is generally associated with motor rooms, to provide electrical conductors between a d-c source and either a main drive or a process.

When a circuit carrying more than 1000 amperes at 1000 volts or less is required, exposed bus provide the most satisfactory and most economical method of carrying the power. The bus may be bare copper or aluminum mounted on porcelain insulator or synthetic insulating material slotted to support the conductors.

For circuits requiring a current carrying capacity of 1000 to 4000 amperes, flat bars are most often used. From 4000 amperes upward, rectangular or structural shapes are available in both copper and aluminum.

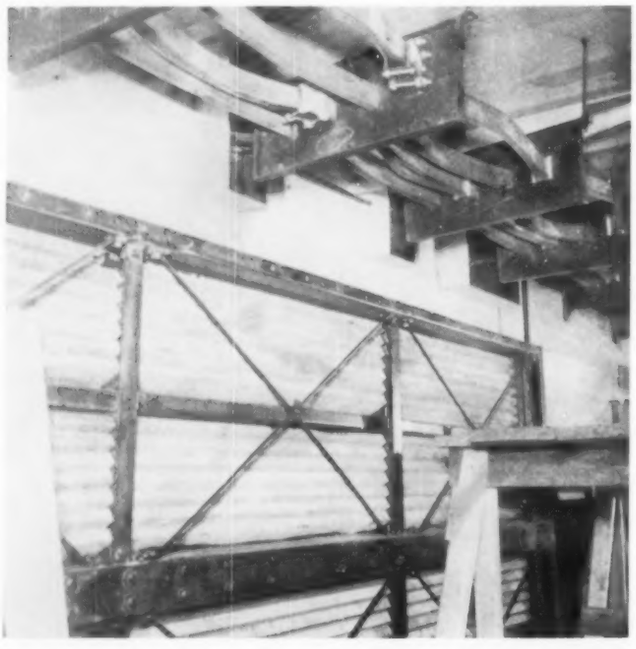
TABLE IV
Conduit Sizes for RCLC Cables-600 Volts-in.

	Number of cables														
	Number of conductors														
	1-Conductor					2-Conductor		3-C	4-C	5-C	6-C 7-C	9-C	10-C	12-C	14-C
Cable size	1	2	3	4	5	1	2	1	1	1	1	1	1	1	1
No. 12 (19/25)	¾	¾	1	1		¾	1-½	1	1	1-½	1-½	1-½	1-½	1-½	2
No. 10 (19/22)	¾	1	1	1		1	2	1	1-½	1-½	1-½	1-½	2	2	2
No. 8	¾	1	1-½	1-½		1	2	1-½	1-½						
No. 6	¾	1-½	1-½	1-½		1-½	2	1-½	1-½						
No. 4	¾	1-½	1-½	1-½		1-½	3	1-½	2						
No. 2	1	1-½	1-½	2		1-½	3	2	2						
No. 1/0	1	2	2	3		2	4	2	3						
No. 2/0	1	2	2	3		2	4	3	3						
No. 4/0	1-½	3	3	3		3	4	3							
300000CM	1-½	3	3	3											
350000 CM	1-½	3	3	4											
500000 CM	2	3	4	4											
750000 CM	2	4	4												
1000000 CM	3	4													
1500000 CM	3														

No conduit smaller than 1 in. to be installed under concrete floors

To properly design a bus installation, a study of fault conditions should be made as soon as basic circuits are established. It should be remembered that instantaneous short circuit stresses become rather large and could destroy the bus system. Figure 7 shows the condition of a bus after a severe fault. Other systems not properly designed have come down completely.

Figure 7 — Bus bars on top are shown after a heavy short circuit.



A simple calculation to provide proper bus supports can avoid a collapse under any fault.

For d-c circuits the formula is:

$$F = \frac{5.4 I_s^2}{10^7 \, d}$$

$$I_s = 17I$$

Where:

F = Maximum force in pound per foot of bus
I_s = Short circuit current
d = Center line to center line of bus in in.
I = Rated current of machines

For single phase symmetrical a-c bus the formula becomes:

$$F = \frac{10.8 I_s^2}{10^7 \, d}$$

And for single phase asymmetrical the formula becomes:

$$F = \frac{43.2 I_s^2}{10^7 \, d}$$

For three phase bus the formulae remain the same with the constant changing according to the bus arrangement. These formulae are available in NEMA standards.

Some refinements can be made in calculating fault stresses in bus by taking into consideration many minor factors. However, this is never necessary since all these considerations added together seldom make much, if any, difference.

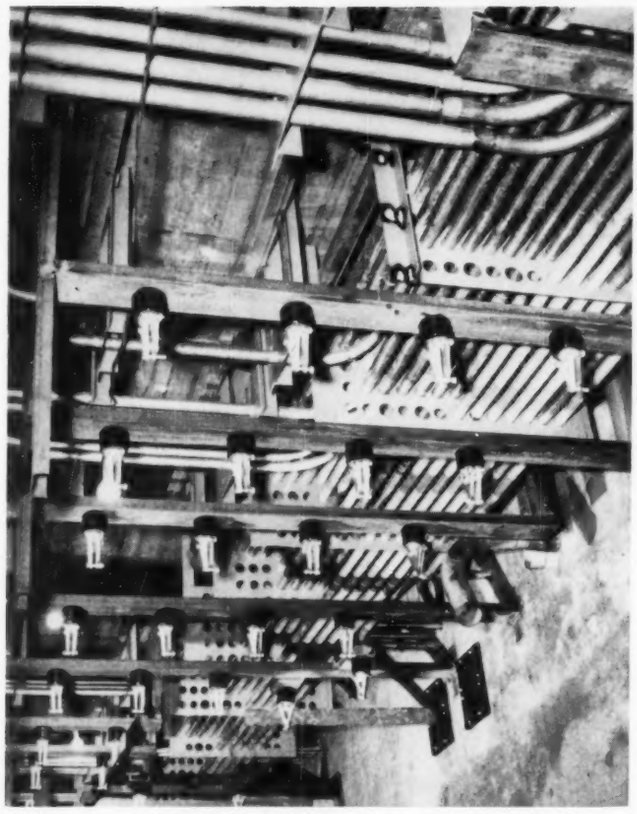


Figure 8 — Insulators should be spaced to support the bus under fault conditions.

In establishing the short circuit current, both the generators and the motors which it drives must be considered as supplying the fault at the instant of its occurrence. At the instant of a fault the motors act as generators and feed the fault.

All insulator manufacturers publish data which provides the cantilever, tension and compression strength of insulators. These should be spaced to support the bus under fault conditions. Figure 8 shows insulators ready to take the bus bars.

To complete the study, deflection and stress formulae for a uniformly loaded beam can be used to determine the distortion which would occur in the bus under fault conditions. It is often necessary when using flat bar to mount the bus bars in a horizontal position to take advantage of the additional strength of bars mounted in this manner. In ventilated motor rooms this makes no difference in current carrying capacity.

Discussion

PRESENTED BY

WALTER J. PRISE, Kaiser Engineers, Oakland, Calif.

A. J. MOSSO, Vice President, Auburn & Associates, Inc., Pittsburgh, Pa.

L. G. LEVOY, Engineering Planning and Development, Systems Application Engineering Section, General Electric Co., Schenectady, N. Y.

J. HUNT, Switchgear Dept., Allis-Chalmers Manufacturing Co., West Allis, Wis.

Walter J. Prise: We believe that to get good power layouts in the steel mills, the electrical characteristics of a new or expanded steel mill must be given due consideration from the very beginning of the job. The single line diagram is the key electrical drawing needed for the design of such a job.

It is good practice to let the electrical engineer responsible for the design, work with the proposal received from the machinery manufacturers. His suggestions can be valuable in the selection of the specialized drives and other electrical equipment used in the mill.

Sometimes it is practical and economical to order the electrical drives directly from the electrical manufacturer. This of course requires good co-ordination with the manufacturer of mill machinery.

We find that under some conditions, especially working in foreign markets, we have to deviate from the accepted American standards and from recommended voltages given in Table II of the paper. Consideration of this kind makes the job of the electrical engineer and the designer more demanding, complicated, and challenging.

After load analysis and short circuit studies are made, we recommend that any primary distribution scheme be checked from the power stability standpoint. On large power systems it is of paramount importance to maintain synchronism during steady state condition and also regain synchronism or equilibrium after a disturbance of the system.

Disturbances on the mill power system can be produced by load changes, switching operations, faults, and loss of excitation. The check for stability may disclose that within available switch clearing time the suggested system becomes unstable. Thus, an investigation of power system stability offers an additional tool for comparison between the power schemes offered for consideration.

The specifications for the job and for individual equipment should be written as clearly as possible. If written in a concise, clear and correct manner, they will prove to be valuable documents and will serve as a guide for the designers in a layout of the power system.

The list of basic principles of good power layouts given in Mr. Mosso's paper is a good guide, and we would like to add that consideration should be given to the future growth of the plant. In the choice between overhead and underground systems of power distribution, although prime cost of the underground system is usually higher, overhead system requires frequent maintenance, such as painting of structures and cleaning the surfaces of insulators.

In the areas where high concentration of moving equipment exists, overhead lines are at a disadvantage from a safety point of view.

In termination of incoming power lines was any consideration given to comparison between outdoor substation structures and indoor switchgears? We find that these two are very competitive. What is the author's experience on this matter?

The author's points on the layout of the motor room are well taken. Among other things, interchangeability of electrical equipment leads to a considerable saving in spare parts. We would like to learn the author's experience on the use of interchangeable equipment. Serious consideration should be given to the easy removal and replacing of armatures from rotating equip-

ment. There is some difference of opinion on desirable location and number of filters in the ventilating system. Screens with rotating layers of filters were adopted by us on some installations. We would like to learn from the author about economic comparison of various ventilating systems mentioned in the paper.

In some areas the use of black enamel conduit is outlawed by local code, but recently a new conduit with metalized surface appeared on the market. Is there enough data available on the use and lasting qualities of this conduit?

In some plants paper insulated, lead covered, steel taped armored cable directly buried in the earth or in tunnels is in extensive use and butyl cables of 6.6-kv and 3.3-kv rating for installation on conduit are quite common. These two types were not mentioned in the paper. Does Mr. Mosso have any specific objection to their use?

In conclusion, from our engineering experience, we know that successful completion of a job depends on a well coordinated effort of the engineer, designer, and construction man. Sound engineering and good practical design, well organized procurement of the equipment and accurate scheduling of all phases of the job are important. Coordination between the structural, mechanical and electrical forces, both in design and construction, are essential. Follow up of all orders and expediting of the critical items, together with proper crating and clear identification marking of the packages and crates, protection of equipment in transit, good warehousing and storage facilities, will reduce the difficulties in installation.

An experienced, ingenious and resourceful engineering field force can meet many adverse conditions that may arise and still come up with a good job well done and on schedule.

A. J. Mosso: Both outdoor and indoor substations are used quite frequently. Although the outdoor substation switchgear is generally more expensive, if you use indoor you have to house it. We would say that economically that is determined best by the particular conditions existing on any given job. If you have space in the motor room for indoor switchgear, we would say by all means use indoor switchgear. If you do not have the space requirements and you have to go outside, the additional cost of a switchgear house and perhaps an associated control house would make the outdoor installation more expensive.

The desirability of having interchangeable equipment, particularly on rotating equipment is very important and it should always be taken into consideration.

On the various ventilating systems our opinion has always been that perhaps the electric precipitator does by far and away the best job, but requires the greatest amount of maintenance. In some cases, not enough maintenance is given to it.

The multi-duty or traveling screen type is used quite frequently and in most cases does a very satisfactory job, requiring a relatively small amount of maintenance.

The throw-away filter type is gaining in popularity. Where special cleaning is required a combination of the electrostatic and the throw-away filter, or some other type of filter, which can take the large particles out after the electric precipitator has coagulated them, is often used. It has gained in popularity in the last several years.

The people from Mr. Prise's company who do most of their work in California and in foreign places have problems that, we realize, are not typical in the east, or the south, or the midwestern part of the United States. They have a much more rigid conduit and cable requirement by code and by law in California. In working jobs in those areas we always give that special consideration.

The underground armored cable is sometimes used. However, the experience of this author is that it is the least desirable of all the methods. First because it is a life hazard to anyone excavating in the area at a later date; and second, armored cable, because of action from chemicals, such as they have in chlorine plants or other chemical areas have a tendency to erode armored cable or conduits buried in the ground.

Mr. Prise makes the comment that a resourceful, ingenious field force can meet adverse conditions and still come up with a good job. This is true. However, the field force should never be expected to handle the engineering. Good engineering drawings will reduce field costs by as much as 10 per cent.

L. G. Levoy: Mr. Mosso has presented an interesting paper which mentions some of the problems which confront engineers as they plan installation layouts.

In selecting cable sizes, the rms load and the thermal time constant of the installed cable may be more significant than the average load in cases where the load is fluctuating over a wide range. These factors should be considered in selecting cable sizes on such loads.

The relation between the 15-min, 1-hr, and 8-hr demand was probably intended to apply to a typical integrated steel plant and not to any individual mill component such as a hot strip mill or to a nonintegrated mill.

With reference to Table II, I wish to call attention to the fact that the EEI-NEMA standards discriminate between "nominal system voltage," "transformer voltate," "motor voltage," etc. For example, while 440, 2300, 4000, 6600, and 13200 volts are preferred utilization voltages, the corresponding "nominal" system voltages are 480, 2400, 4160, 6900, and 13800 volts. To avoid confusion, it is desirable to discriminate between nominal voltage ratings and utilization equipment ratings in accordance with established standards.

The grounding system should be adapted to the electrical layout in such a way as to minimize hazards to personnel, equipment, and buildings. The equipment grounding system which is mentioned is important and should be designed carefully. Recent studies indicate that for a-c circuits it is important to provide a ground return path close to the outgoing conductors. Thus it is important not only that every metallic conduit be grounded, but also that it provide a continuous ground path back to the source and as close as possible to the outgoing conductors at all points in the circuit to be effective.

Equally important for a-c systems is the system neutral ground circuit. Much has been written on this subject. It is important that proper consideration be given to system neutral grounding in the planning

stages before equipment orders are placed.

In speaking of conduit layouts, the author mentions the fire hazard in cable trays. Proper system neutral grounding, along with proper equipment ground circuit design, proper cable selection, and proper circuit relaying can reduce the possibility of such fires to a minimum. Fires of this nature are generally caused by deficiencies in one or more of these items.

With regard to cables, for many years paper-insulated lead covered cables were the common choice and they have given excellent service records. However, many modern steel mills and other industrial plants are using the newer synthetic rubber-like insulations in the 2.4 to 13.8-kv range. The advantage of these cables is the elimination of potheads which are essential on lead jacketed cables. Potheads are expensive to install and require a high degree of skill to make them as reliable as the rest of the cable.

Also, many of the newer plants are using interlocked armor cables for circuits above ground as they are finding this more economical than conventional cable and conduit installations.

While it is true that modern plastic insulations can be obtained which are both acid and water resistant, one earmark of a good conduit system is that it should be self-draining to eliminate moisture accumulation from condensation or other causes. The presence of moisture accumulation is undesirable because it eventually results in rusting of the conduit, making it difficult if not impossible to withdraw the cable.

We do not agree with Mr. Mosso's philosophy on ventilation systems. He states that non-recirculating systems are by far the most popular and advises they be built using the up-draft scheme. It has been our experience that non-recirculating up-draft systems, with their attendant hot motor rooms, are being superseded by down-draft systems of both the non-recirculating and recirculating types. It is true up-draft systems are popular, when the equipment is located in the mill area.

Mr. Mosso may be basically correct in his remarks on the inadequacy of electrical manufacturers interconnection diagrams, but our company makes a special effort to provide complete service in this respect, if desired. We were surprised to note that it is recommended that a complete new interconnection diagram be made covering all the equipment involved. It is our feeling that a complete list of conduits and conductors should be all that is necessary to properly coordinate the many independent wiring and interconnection diagrams.

BIBLIOGRAPHY

1. "*Some Fundamentals of Equipment Grounding Circuit Design*," by R. H. KAUFMANN, AIEE Applications and Industry, Nov. 1954, pages 227–232.
2. "*Industrial Power Systems Handbook*," edited by D. L. BEEMAN, McGraw Hill Book Co., Inc., 1955.
3. "*A Compendium of Grounding Techniques for Personnel and Equipment Protection*," by H. E. HEDDESHEIMER, AIEE Paper No. 57-920.

A. J. Mosso: We must agree with Mr. Levoy and Mr. Prise that fault and system stability studies are a part of the job. These subjects are both so broad in scope and have been so adequately covered in past papers that we did not feel that they should be made a part of this paper.

Mr. Levoy's comments on fire hazards in cable tray layouts, overlooks the chief cause of fires in such a system. Porous concrete or cracks in concrete often permit combustible liquids to fall on cables in the trays. A small spark will then cause a major fire regardless of proper grounding, proper cable selection and relaying. The safety inspectors of one large steel corporation are giving particular attention to cable tray installations to be sure that the cable is not exposed to combustible material. This author's opinion is that there is no good substitute for a good conduit layout with the power cables fireproofed at the junction boxes.

Mr. Levoy points out that the advantage of synthetic cable over paper insulated lead covered is the elimination of the need for potheads. This advantage is more than lost in the need for larger conduit to take the synthetic rubber cable which has a much larger diameter for the same voltage rating. It is also the opinion of this author that if synthetic insulation is used on voltages above 5 kv that a stress cone should be used, the installation of which requires even more skill than the building of stress cones in potheads.

Several of the people making comments have asked for our experience with interlocked armored cable. In some applications, armored cable provides an excellent means of transporting electrical energy. In some cases it offers the advantage of economy. However, it has the disadvantage of not providing as much mechanical protection for the conductors. Some mill engineers complain that the armor is too soft if aluminum armor is used and they also find it difficult to paint galvanized armor. The ideal armor is stainless steel but the cost of this quickly approaches a conduit and cable installation. Perhaps, there is yet no good substitute for a good conduit and cable installation.

Self-draining of outdoor conduit runs at the manholes and junction boxes is absolutely necessary. However to worry about embedded conduit in motor rooms and mill floors is unnecessary. Imbedded conduit, inside a mill, dug up after 30 to 50 years of service will often be found in good condition. The inability to pull out cable generally indicates that the cable in failing has become brazed to the conduit.

In reviewing our job record for the past 10 years, we find some interesting statistics on ventilating schemes. For these mills, where a customer in most cases expressed a preference for his favorite scheme, the ratio of up-draft and down-draft schemes is three to one. For cold mills, rod mills, pipe mills and processing lines where much of the electrical equipment is in the mill area, the up-draft scheme is used almost exclusively. Approximately 20 per cent of the blooming, bar, or hot mills, where the electrical equipment is for the most part housed in a motor room, used the up-draft scheme. Only five per cent used a recirculating scheme because of its greater initial cost and increased maintenance. Air-to-water heat exchangers, pumps, and, in some cases, cooling towers add considerably to the cost of equipment and maintenance of a recirculating system.

The disadvantage of a down-draft system is a cold motor room in winter and the up-draft system causes a hot motor room in the summer. Both conditions can be

relieved considerably by good design. The choice should be made after a study of the particular conditions existing on the specific job.

Perhaps the pet "peeve" of every electrical engineer in the steel industry is the delay experienced in obtaining wiring diagrams for a new mill. Some of the electrical manufacturers are withholding the release of panel diagrams until test floor changes have been made. These diagrams, because of the nature of the job, are the information last received. The additional delay is highly undesirable.

Often the manufacturer substitutes an interconnection diagram for the panel drawing. In twenty-five years of experience, this author has yet to see a set of these diagrams which was not incomplete, poorly marked, and not at all coordinated with the remaining electrical components of the job.

The real problem in making an electrical layout for a mill is not the basic circuits, that is, connections to main drive motors and motor-generator sets, but the multitude of small details such as the interlocking, the solenoids, limit switches, remote control points and the miscellaneous items not directly a part of the mill, such as sump pumps, electrically-operated doors, space heaters, etc. We do not remake interconnection diagrams to find something to do; most mill engineers insist on this being done. Some mills insist on reproducing even the panel diagrams so that the scheme, the detailed diagram and the interconnection diagram all be on one sheet.

By having the panel diagrams and making our own interconnection diagrams, we find the following advantages to everyone concerned with the job:

1. The installation contractor saves wiring time and and can get his job done with less supervision.
2. Making interconnections provides a check to assure that every wire has a conduit route.
3. The electrical manufacturer benefits since, by doing this work, we find many of the oversights in interlocking and some of the system "bugs" which reduce the manufacturer's problem at "start-up" time.
4. The customer saves both money and time because coordinated interconnection diagrams facilitate field wiring.
5. The maintenance group who takes over the mill has a complete story on every wire in the mill.

It is true you can get by without a good set of interconnection diagrams. It is our belief that if the job is worth doing at all, it should be done thoroughly and completely. "Getting by" is not good enough when drawings are your end product.

J. Hunt: Mr. Mosso is to be commended for attacking the subject of power layout in a steel mill in the *one best* way of solving such a complex collection of problems; that is by systematic attention to each of the small details which together comprise the electrical system. It should be reviewed by all facing this common problem.

As electrical equipment manufacturers we are happy to have him point out that in furnishing electrical equipment and its interconnection diagrams, our function does not extend to the wiring layouts of the mill. He has touched in several places on the interdependence of the electrical manufacturer and the consulting engineer. We are fully aware of it.

We have been using the network analyzer as a tool in several facets of system design, such as short circuits, momentary currents, voltage studies, motor starting problems, system stability studies. However, we must wholeheartedly agree that grounding is an empirical science. It is an important matter as Mr. Mosso points out. ▲

There is a demand for copies of the following Yearly Proceedings:

1936 1937 1938 1939 1940

1943 1944 1947 1952

If your copies are not in use please get in touch with us.

ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

TENTATIVE PROGRAM

AISE Spring Conference

AUSPICES OF ROLLING MILL COMMITTEE

THE DINKLER-TUTWILER HOTEL BIRMINGHAM, ALA.

APRIL 21, 22, 23, 1958

"Improved Lubrication in Cold Strip Rolling," by J. C. Whetzel, Jr., and Sayre Rodman, Partners, Allegheny Refining Co., Verona, Pa.

"Maintenance of Back-Up Roll Bearings in Strip Mills," by W. M. Lewis, Master Mechanic Sheet, Tin & Strip Div., Bethlehem Steel Co., Sparrows Point, Md.

"A Punched Card Program and Data Logging System for a Tandem Cold Strip Mill." by Orville E. Orbom, Manager, Electro Mechanisms Dept., Allegheny Ludlum Steel Corp., Brackenridge, Pa., and R. M. Sills, Application Engineer, Steel Mill Engineering, Systems Application Engineering Section, General Electric Co., Schenectady, N. Y.

"Selection and Control of Electrical Equipment for Modern Foil Mills," by Warren Reid, Steel Mill Engineer, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa., and D. E. Abell, Supervisory Engineer, Steel Mill and Metalworking Section, Systems Control Engineering Dept, Westinghouse Electric Corp., Buffalo, N. Y.

"Electrical Equipment for a High Speed Annealing Line," by J. E. Butler, Chief Electrical Engineer, Weirton Steel Co., Weirton, W. Va., and Willard G. Cook, Manager of Industry Engineering, Elliott Co., Pittsburgh, Pa.

"Thermit Welding Structural Mill Rolls," by Edward B. Russell, Assistant to Superintendent, Mechanical Shops, Kaiser Steel Corp., Fontana, Calif.

"Hardening Forged Steel Rolls by the Progressive Induction Heating Method," by John M. Dugan, Works Manager and Chief Metallurgist, The Ohio Steel Foundry Co., Lima, Ohio

"Pre-Cast Panel Construction for Furnaces," by R. J. Demaison, Vice President and Technical Director, and E. W. Garvin, Jr., Vice President, Charge of Sales, Quigley Co., Inc., New York, N. Y.

"Recent Furnace Installations," by O. D. Rice, Vice President and General Manager, and R. W. Ewalt, Sales Manager, Rust Furnace Co., Pittsburgh, Pa.

"Soaking Pits with a High Velocity Combustion System," by D. C. Haney, Assistant Superintendent, Fuel and Power Dept., Youngstown Sheet and Tube Co., Youngstown, Ohio

"Rolling of Metals," by J. I. Greenberger, Group Engineer, United Engineering and Foundry Co., Pittsburgh, Pa.

"An Analysis of the Mechanics of Cold Strip Rolling," by Donald Jortner, Allegheny Ludlum Fellow in Mechanical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa.

"Mannesmann's New Seamless Mill at Sault Ste. Marie," by Astor L. Thurman Executive Vice President, and Robert Hartenstein, Vice President—Engineering, Mannesmann-Meer Engineering and Construction Co., Inc., Easton, Pa.

"Gear Couplings for Steel Mill Drives," by P. Hollingsworth, Chief Engineer, Fast's Coupling Dept., Metals Products Div., Koppers Co., Inc., Baltimore, Md.

"Hydraulic Jet Descaling—A New Method to Remove Scale from Hot Steel Ingots, Blooms, Slabs, Billets, and Bars before Rolling," by Benj. G. Harmon, Senior Partner, Harmon and Co., Chicago Ill., and Robert V. Proctor, Vice President, Engineering, Commercial Shearing & Stamping Co., Youngstown, Ohio

"Automatic Continuous Lubrication of Universal Mill Spindles," by William L Stover, Assistant Chief Engineer, Mesta Machine Co., Pittsburgh, Pa.

"From Ingot to Ingot in Fifteen Days—Replacing a 27-In. Universal Slabbing Mill with a 38-In. x 66-In. Universal Slabbing Mill on the Same Site," by D. H. Sampson, Mechanical Engineer, Dominion Foundries & Steel, Ltd., Hamilton, Ontario, Canada

"Republic's Flat Rolled Expansion in the South," by L. S. Mobley, Chief Engineer, Southern Steel District, Republic Steel Corp., Gadsden, Ala.

OFF-THE-RECORD ROLLING MILL PANEL DISCUSSION

The following topics will be covered in this panel discussion:

(1) Factors which affect the shape of strip off hot and cold mills.
(2) Roll neck bearing performance on various types of mills (antifriction, oil film, composition).
(3) Looping and repeating.
(4) Inspection and trimming practices on rod and merchant coils.

INSPECTION TRIP—April 23, 1958

Republic Steel Corp., Southern Steel District, Gulf Steel Works, Gadsden, Ala.

Seamless Tube

THE general plan of the seamless tube mill at Phoenix Iron & Steel Co's plant at Phoenixville was projected by Albert Calmes, of Milano, Italy. The details of the mill were designed by the Phoenix Iron & Steel Co's engineering department, with some aid from outside engineering companies. The Calmes patents on press piercing, his patents on modification to the Mannesmann elongation and his contour of the pilger mill rolls formed the nucleus around which the mill was designed, in order to manufacture quality pipe with close tolerances of both the outside diameter and wall thickness on all grades of steel.

The mill will make seamless tubes from 5½ to 16 in. in diam. with wall thicknesses of ¼ to 3 in., starting with round corrugated ingots, which may weigh as much as 8000 lb. The ingots are top poured at Phoenix Iron & Steel Co's open hearth furnaces.

One of the outstanding features of the mill is that it takes ingots directly from the open hearth and makes seamless tubes in one continuous process. Press piercing, elongating, and rotary forging are performed in one heating cycle.

The main operations are ingot conditioning, ingot heating, press piercing, elongating, rotary forging (performed on a pilger mill), reheating, sizing, polishing, finishing, and testing. This paper deals mostly with the fundamental parts of the process which are press piercing, elongating and rotary forging.

The ingots are flame trimmed if necessary and all are flame scarfed in order to remove any surface defects. They are heated in a car type radiant heat furnace until thoroughly soaked to a temperature of 2340 to 2370 F. In order to achieve a straight and even walled hollow bloom, core and skin temperatures must not differ by more than 50 F. The ingots are set on piers and all sides subjected to radiant heat, giving the desired heating condition. Upon being discharged from the furnace they are carried by conveyor to the press for piercing.

Press piercing is accomplished in a 1200-ton hydraulic pierce press which was manufactured in Italy. This press was selected as it was the only known means to pierce cast steel ingots without creating inside laminations or fissures. It also makes the steel structure more homogenous and increases the tube yield. The ingot is inserted into the piercing press by a hydraulically operated charger, which places it in piercing position on the support rests, one of which is attached to the container, the other being retractable. The container and its sleeve is pushed around the ingot. It is the inside of

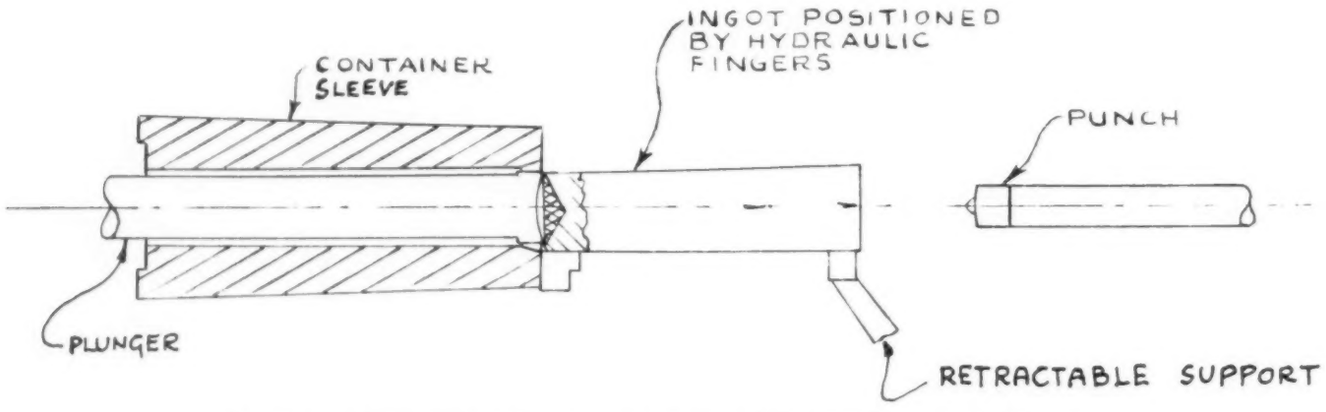
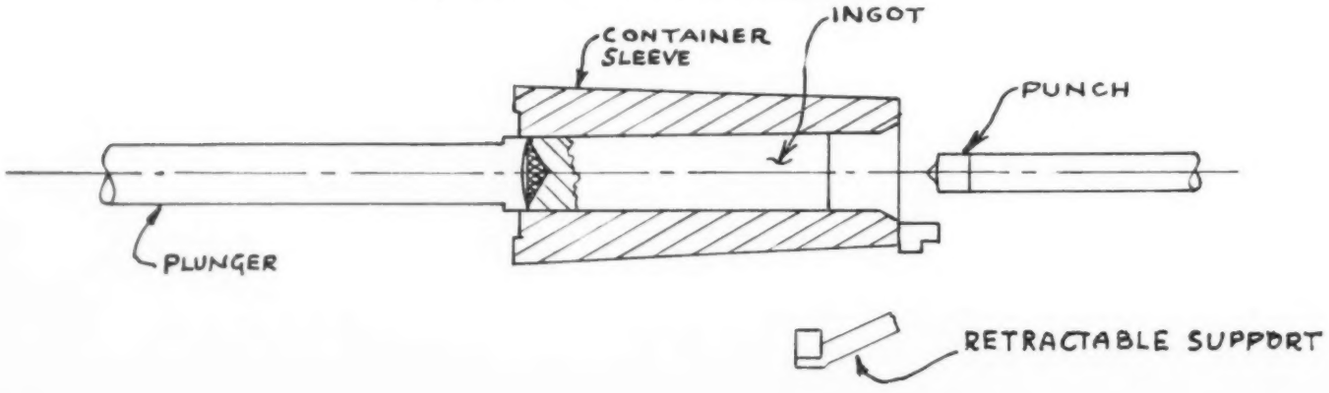


Figure 1 — Container is shown before it is pushed over the top end of the ingot.

Figure 2 — Container sleeve has a slight taper.



. . . . this mill has as one of its outstanding features the ability to take ingots directly from the open hearth and make seamless tubes in one continuous process . . . .

Making by the Calmes Process

by DR. ALBERT CALMES,
Albert Calmes & Co.,
Milan, Italy
and CLYDE A. ROBERTS,
Chief Engineer,
Phoenix Iron and Steel Co.,
Phoenixville, Pa.

this sleeve that determines the outside diameter of the pierced ingot. The inside diameter of the container sleeve is just large enough to slip over the ingot, because it is desirable to have as little clearance as possible between the ingot and container sleeve. The punch determines the inside diameter of the pierced ingot, referred to by us as a bottle.

Figure 1 shows the container before it is pushed over the top end of the ingot. After the container has moved through about 75 per cent of its stroke, the retractable rest is lowered out of the way. Figure 2 shows the ingot in the container sleeve.

The piercing starts at the bottom of the ingot and as the hole is punched, the ingot is elongated. This elongation, which is the ratio between the length of the bottle and the ingot, should not exceed 1.3. Different size sleeves are required for each ingot size and the punch varies with the size of the elongator plug to be used.

Figure 3 shows the completed bottle still in the sleeve. Note that the top and poorest part of the ingot has been pressed to the very bottom of the bottle. The piercing press was especially designed to give the bottle a very thin bottom and in many instances the hole is punched almost all the way through.

For ease of removing, the container sleeve has a 1 per cent taper and since the plunger is stationary, stripping is accomplished by returning the container to its original position. The bottle does not actually move. The retractable rest or support is moved back in place as soon as the container sleeve starts to return. When the container is clear of the bottle, a hydraulically-operated discharger is raised from below and deposits the bottle on the elongator charging device.

The piercing press can use either square or round ingots, but to date only the round corrugated ones of 13, 16, 19 and 21 in. in diam have been used. In the future, for certain small sizes, squares may be used which will probably be rolled on the blooming mill.

The press operates with water at 2800- and 1500-psi pressure and is controlled by manual valves located on an elevated pulpit.

The bottle could go direct to the rotary forge mill, if it were not for its bottom and if it was the correct size. Piercing leads to eccentricity if the ingot is not evenly heated and the ratio L/D is greater than 6, where:

L = depth of bottle hole,
D = diameter of piercing punch + ½ in.

Therefore going directly from the piercing press to the

Figure 3 — As the hole is punched, the ingot is elongated.

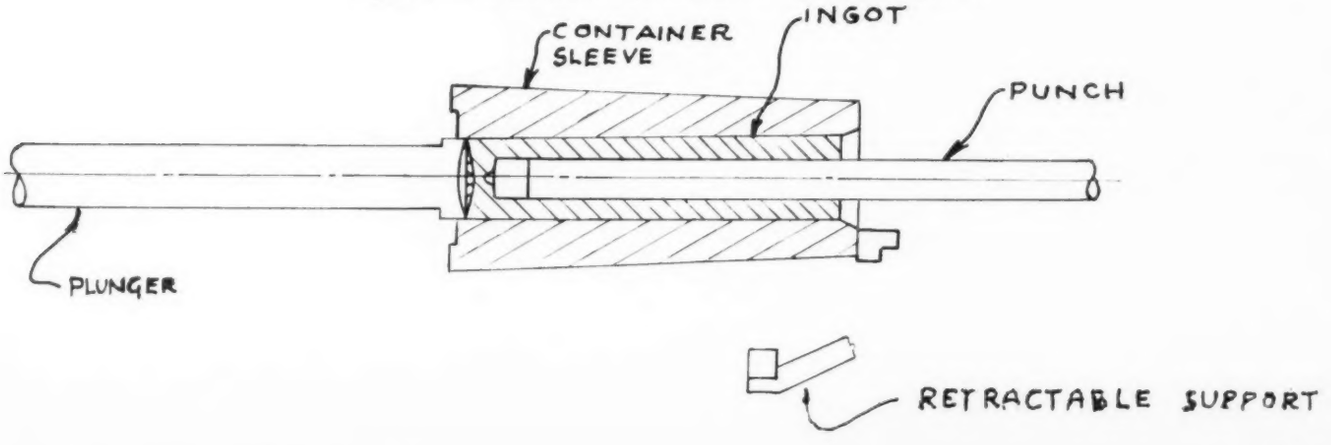


Figure 4 — The elongator is similar to the Mannesmann mill.

rotary forge would require the use of short ingots. This would not be very economical nor could we make double length of API tubes or commercial lengths of heavy wall pipes. By use of the elongator, which also equalizes the wall thickness of the hollow bloom; it is possible to utilize bottles when the L/D ratio is as high as 9 or 10.

In the elongator, the bottle is rolled over a special shaped plug by two cross rolls oppositely inclined about the horizontal plane. In the vertical plane, two stationary shoes maintain a preset bloom diameter and prevent too much ovalization, which we shall refer to later on. As seen in Figure 4 the elongator is very similar to the Mannesmann mill. The elongator lengthens and also completes the punching of the bottle producing a hollow bloom.

The mill was designed to use the Calmes roll contour for certain sizes and the Mannesmann contour for other sizes. The Calmes contour of the elongator roll allows from 1½ to 2⅞ in. reduction on the outside diameter of the bottle and this was used on making 6, 8, 10, and 12-in. tubes. The Mannesmann contour of the elongator roll allows up to only 1½ in. reduction on the outside diameter which was used for making 7-, 9-, 11-, 14-, and 16-in. tubes.

Figure 5 shows the Mannesmann roll in the process of elongating a bottle. Note the shape of the piercing plug and the flow of the metal. Figure 6 shows the Calmes roll. Note the shape of the plug and the flow of the metal.

Due to the expense of changing the rolls Phoenix Iron & Steel Co. developed a roll contour, which when used with two sets of newly designed top and bottom shoes, rolls all sizes of hollow blooms. The Phoenix contour roll allows any reduction up to 2⅞ in. It is necessary only to change shoes for either small (up to 1½ in.) or big (1½ to 2⅞ in.) reduction. Figure 7 shows the Phoenix roll. Note the shape of the piercing plug and the flow of the metal.

We prefer to hold the elongation to 1.75, and in no case do we exceed two. Figure 8 shows a curve in which was plotted the displaced volume per time unit in cubic inches per second against rolling power in horsepower. Note that the Calmes roll has a considerable advantage over the Mannesmann roll and under certain rolling conditions has a slight advantage over the Phoenix roll contour.

In order to have a more flexible mill, we changed the rolls on the elongator to the Phoenix contours, and also the angle of inclination of the cross rolls from 4 to 3 degrees. This change, besides reducing the horsepower requirements, gave a hollow bloom with closer tolerances. Rolling time was increased, but on the other hand, the amount of slippage was reduced giving only a slight increase in rolling time.

The elongator is driven by a 3000-hp, 150-rpm, 6900-volt, 3-phase, 60-cycle synchronous electric motor. The mill is coupled to the motor by a 3 to 1 ratio pinion gear.

One of the main features of the elongator is that it produces hollow blooms of uniform wall thickness regardless of any previous eccentricity.

For better evidence of the proceedings at cross roll elongating, refer to Figure 9, which shows a horizontal section through a bottle being rolled into a bloom, the arrangement of the rolls with the Phoenix contour and the position of the plug. We subdivide three different zones such as:

1. Zone between A and B where the bloom, after being pushed between the rolls, is gripped and by cross

Figure 5 — Flow of material with Mannesmann rolls.

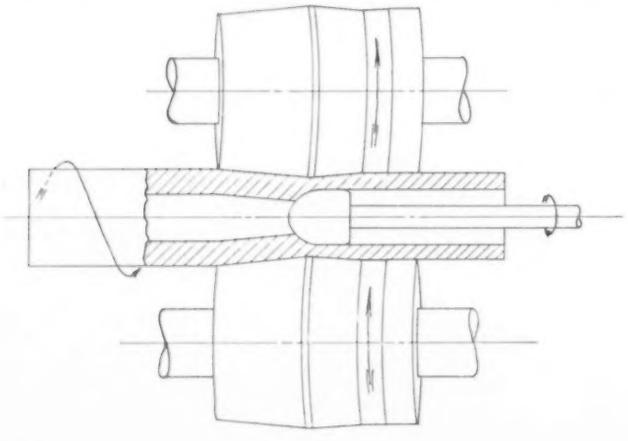
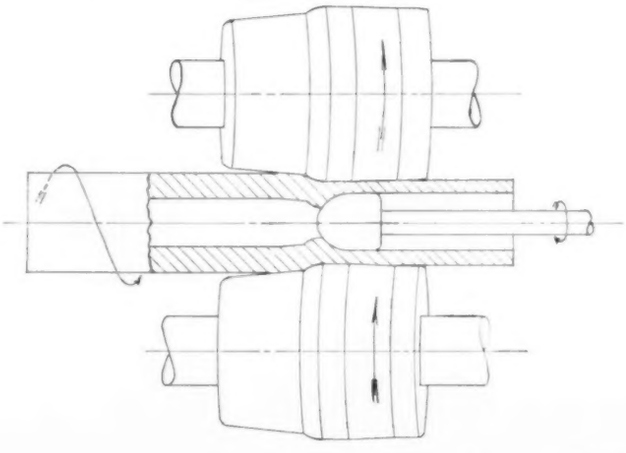


Figure 6 — Flow of material with Calmes rolls.



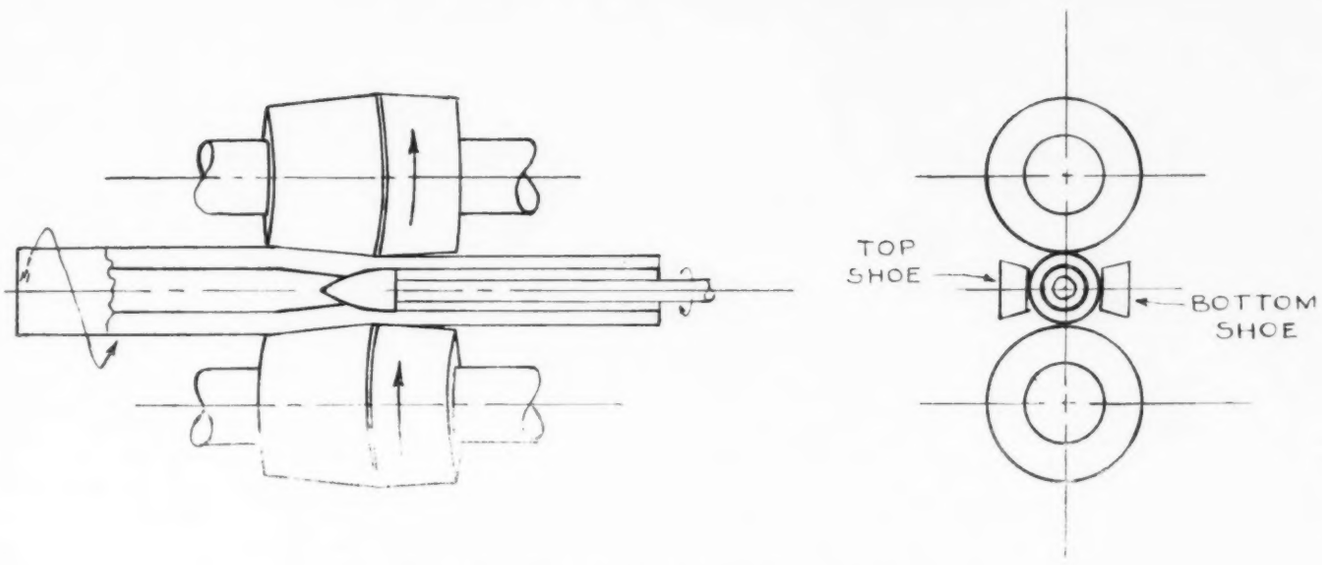


Figure 7 — Flow of material with Phoenix rolls.

rolling advanced into the mill, where due to the contour of the rolls the outside diameter becomes smaller. This may be further clarified by Figure 10, which also demonstrates the fact that the wall thickness remains almost the same.

2. The zone between B and C is called the wall reducing zone. It is in this section that the inside diameter is formed along the contour of the plug and the elongation is caused by forming the wall between the rolls and the plug. As the bottle passes over the plug, the wall thickness becomes increasingly smaller until it is permanently established. As the observed bloom section leaves the end, the wall thickness is the shortest distance between the plug and the roll. The forming of the wall is further demonstrated by Figures 11 and 12. The major wall reduction takes place in the first part of this zone Figure 10 followed by gradually decreasing reduction, as it passes over the back end of the plug, Figure 12. This takes place in 10 to 15 revolutions of the bloom.

3. The zone between C and D may be called the finishing zone. It is obvious from Figure 12 that as the bottle leaves the plug at D it has an oval section. Because of the shape of the shoes in this zone, this oval section is made round.

After the bottle leaves the rolls and becomes a hollow bloom, the thrust gate that holds the plug bar is opened and the hollow bloom is conveyed out of the elongator. A cross conveyor carries the hollow bloom to the pilger mill feeder.

This feeder was manufactured in Italy, and has two carriages, one for 6-, 7-, and 8-in. pipe, and the other for 9-, 10-, 11-, 12-, 14-, and 16-in. pipe. The carriages are removable and only one is on the feeder at a time.

In sequence the operations of the feeder are as follows:

Figure 8 — Curves give power required for displacing metal when using the several roll contours.

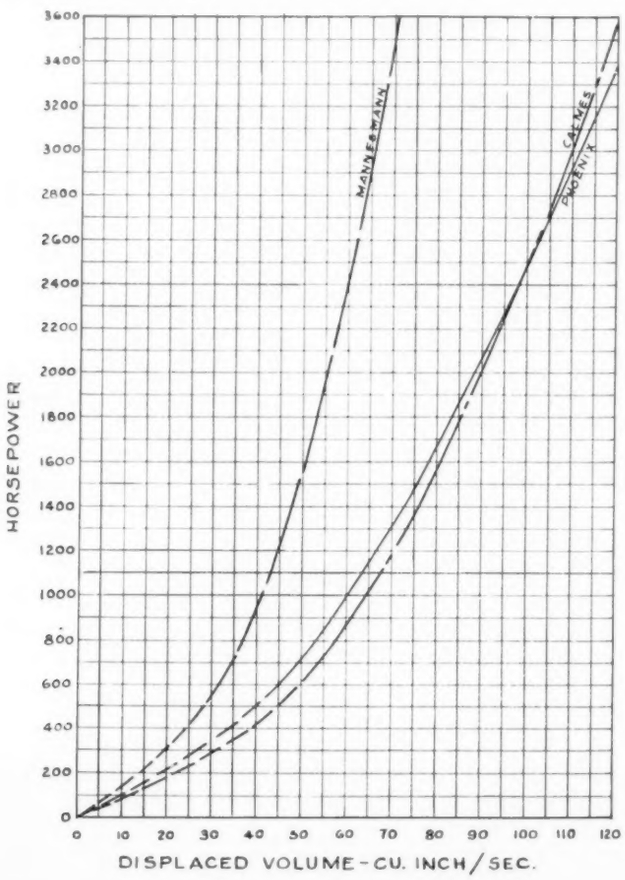
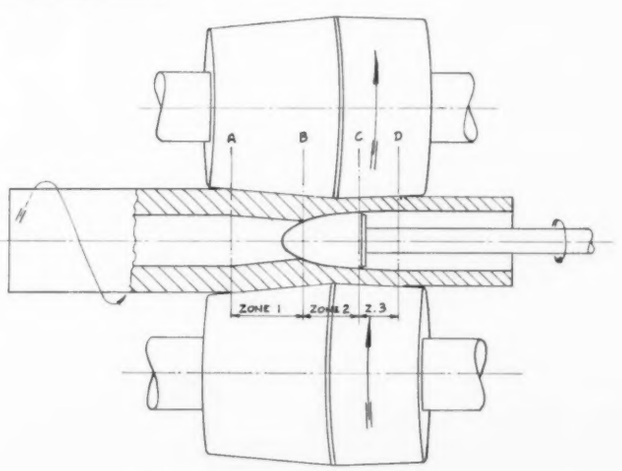


Figure 9 — Horizontal section through bottle being rolled into the bloom.



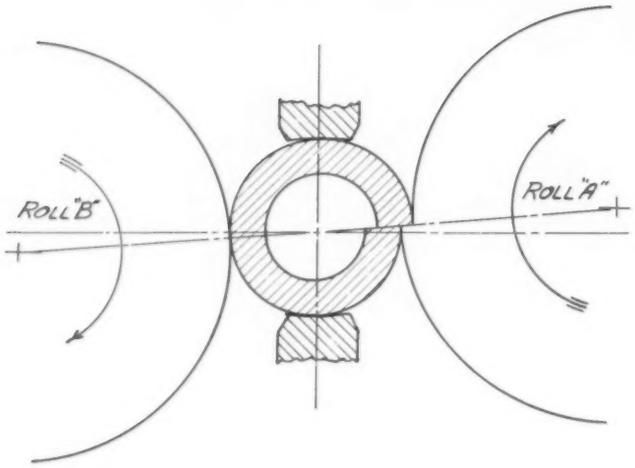


Figure 10 — Outside diameter becomes smaller but wall thickness remains about the same in zone between "A" and "B."

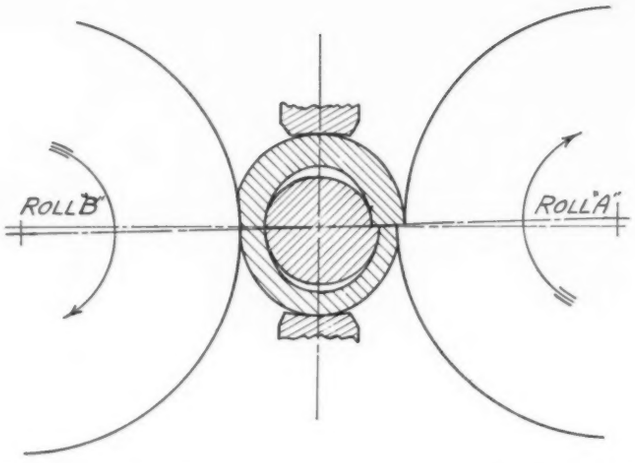


Figure 11 — Wall becomes thinner in zone between "B" and "C."

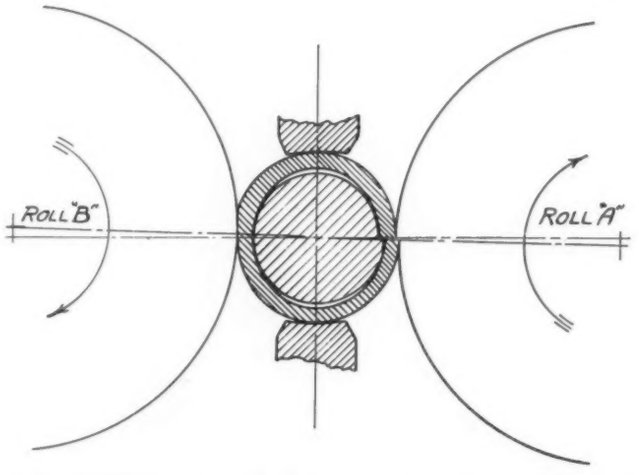


Figure 12 — Sketch shows tube passing over back end of plug.

1. It must receive the hollow bloom from the cross conveyor and insert in it the mandrel bar over which the pipe will be forged.
2. It must feed, for pointing, the hollow bloom and the mandrel bar into the mill.
3. It must permit the backward movement of the mandrel during the forging operation and power the forward motion of the mandrel during the idle zone of the rolls.
4. It must rotate the mandrel and the hollow bloom 90 degrees during each forward motion.
5. It must feed the mandrel and hollow bloom an additional $\frac{3}{4}$ to $1\frac{1}{2}$ in. per revolution for the bite.
6. It must withdraw the mandrel from the forged pipe.

The feeder is discussed later after talking about the rotary forging process.

The diameter of the mandrel bar determines the inside diameter of the pipe. The separation of the rolls determines the outside diameter of the pipe. The rotary forging mill is a two-high, single-stand mill. The roll of this mill is a specially shaped cam whose outer surface is formed by a segmental circular cut of varying depth. The included angle of this segment is 120 degrees and the radius of this segment varies around the circumference of the roll with the cam contour. The sum of the cam radius and the radius of the segment is constant. See Figure 13, section xx. When the two rolls are placed on top of each other with their axes parallel and the rolls matched, one sees an almost round hole on a plane that passes through both axes of the rolls. This hole varies in diameter as the rolls are rotated (Figure 14).

Figure 13 shows a cross section of the two rolls with a hollow bloom being forged over the mandrel. The line ABCA shows the cam surface of the roll. The section through the roll was taken through the centerline of the pipe. The space between A and B is the working zone of the roll. The space BC is the finishing zone of the roll, and space CA is the idler zone. Figure 13 shows a partially forged pipe with the bloom being inserted into the idler section of the roll. Note that the direction of the mandrel bar and the hollow bloom are opposite the direction of rotation of the rolls. Figure 15 shows the working zone of the mill just biting the bloom. The working zone forces the bloom and mandrel bar back against the feeder. This movement is opposed by an air cylinder. As the idle zone occurs, the compressed air moves the bloom and mandrel back to its original position. Figure 16 shows the position of the mandrel bar and hollow bloom after the rolls have rotated approximately 20 degrees. The mandrel bar and hollow bloom are still being forced back against the feeder and the pipe is being forged forward in the opposite direction over the mandrel. Figure 17 shows the finishing zone of the mill doing the work. It is still forcing a flow of metal in a direction opposite that of the mandrel bar. Note the mandrel bar is still being forced in a direction opposite to that of its normal hydraulic feed, until the working surface of the roll comes to a point C, at which time the air pressure, which was built up, forces the bloom and mandrel bar forward, and at the same time turns the mandrel bar and hollow bloom approximately 90 degrees. By the time the roll has returned to point A, the entire feeder has moved forward permitting the new bite and the air cylinder has advanced to its full stroke. This cycle is repeated until the pipe is completely forged.

One nice feature of the feeder is, that the length of the air cylinder stroke is constant for each carriage. It is 30 in., for the 6-, 7-, and 8-in. pipe, and 33 in. for the 9- to 16-in. pipe. This means that the distance along the line ABC which is the working surface of the roll is the

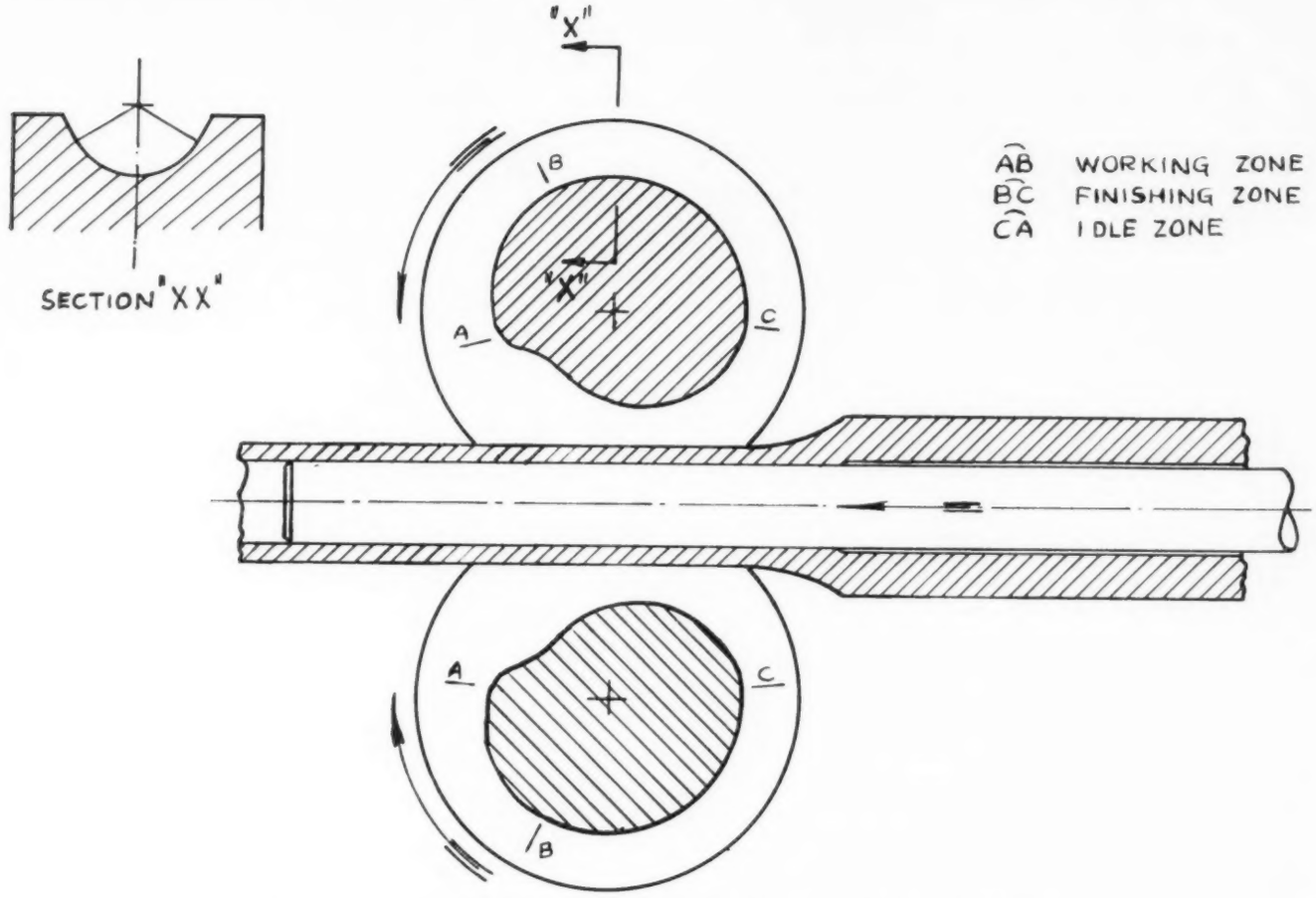


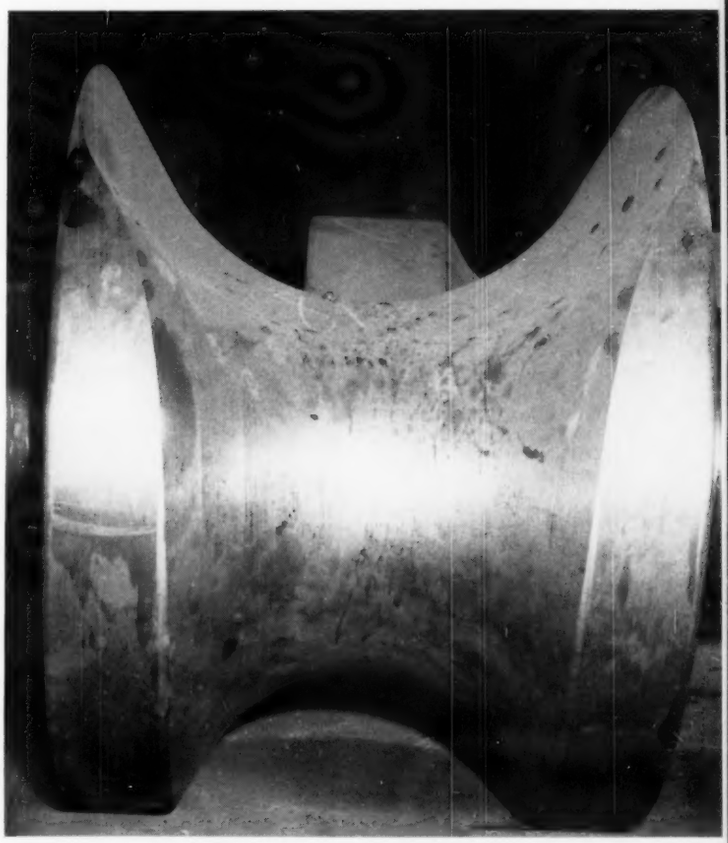
Figure 13 — Diameter of mandrel bar determines inside diameter of pipe.

same for each carriage. The cams in the lathe that cuts the rolls are set to make the working surface the same for each carriage. The direction of the feed is opposite to that of the rolls, and the speed of this feed is controlled by the operator. It is necessary that he synchronizes the speed of the feeder with that of the rolls.

The mill is driven by a motor that is rated 2000 hp but it is capable of developing 3000 hp without excessive heating. The shaft of the motor has a large fly-wheel which absorbs the peak load of each revolution of the roll. The fly wheel loses and gains its energy in each revolution. The speed of the mill is from 30 to 105 rpm. The low speeds are used on the heavy pipe and the high speeds on the small pipe.

The feeder can operate on either 1500- or 2800-psi water pressure, and has a separate cylinder for the forward feed and two cylinders for the return. In normal operation the pressure is continuously applied to the advancing cylinder and when it is desired to feed forward, water is bled from the return cylinders. The speed of the forward feed is then controlled by the amount of water bled from the return cylinders. This is manually controlled at the discretion of the operator while pointing, and automatic during forging. As mentioned before, the operator synchronizes the forward speed of the feeder, which includes the carriage and mandrel bar, with the speed of the rolls. It is also necessary for the operator to control the air pressure. This is especially true during the pointing operation. It often becomes necessary while inserting a hollow bloom to quickly bleed air out of the cylinder. However, after the rolling has started and the

Figure 14 — Illustration shows shape of roll.



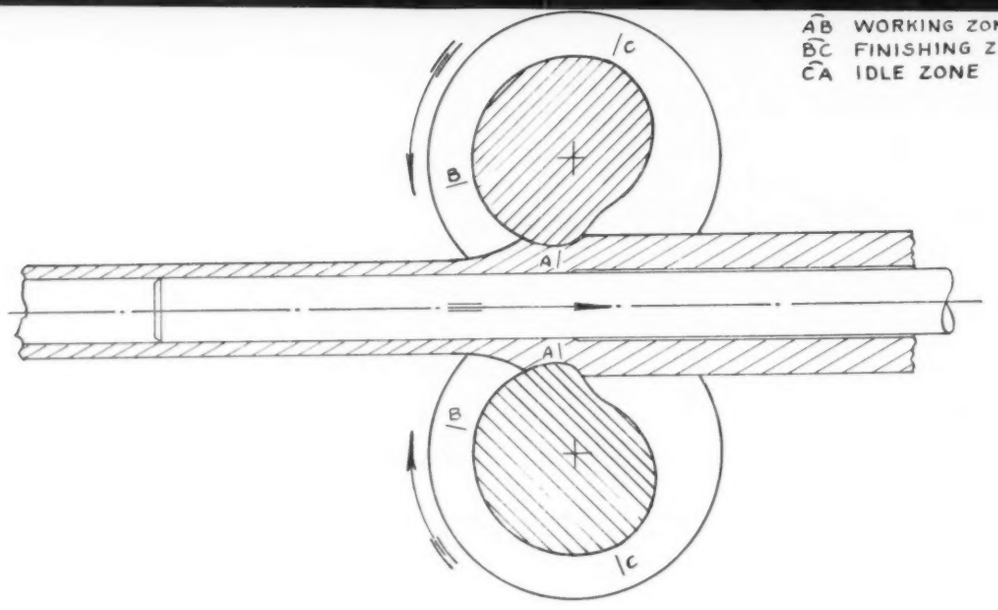


Figure 15 — Sketch shows working zone of the mill just biting the bloom.

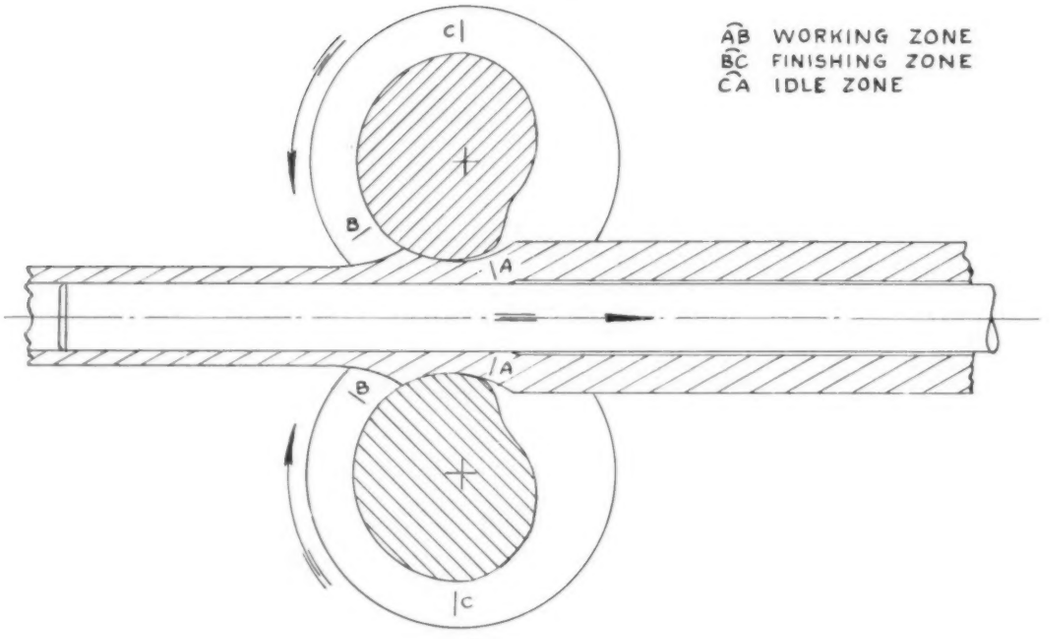


Figure 16 — Sketch shows position of mandrel bar and hollow bloom after the rolls have rotated about 20 degrees.

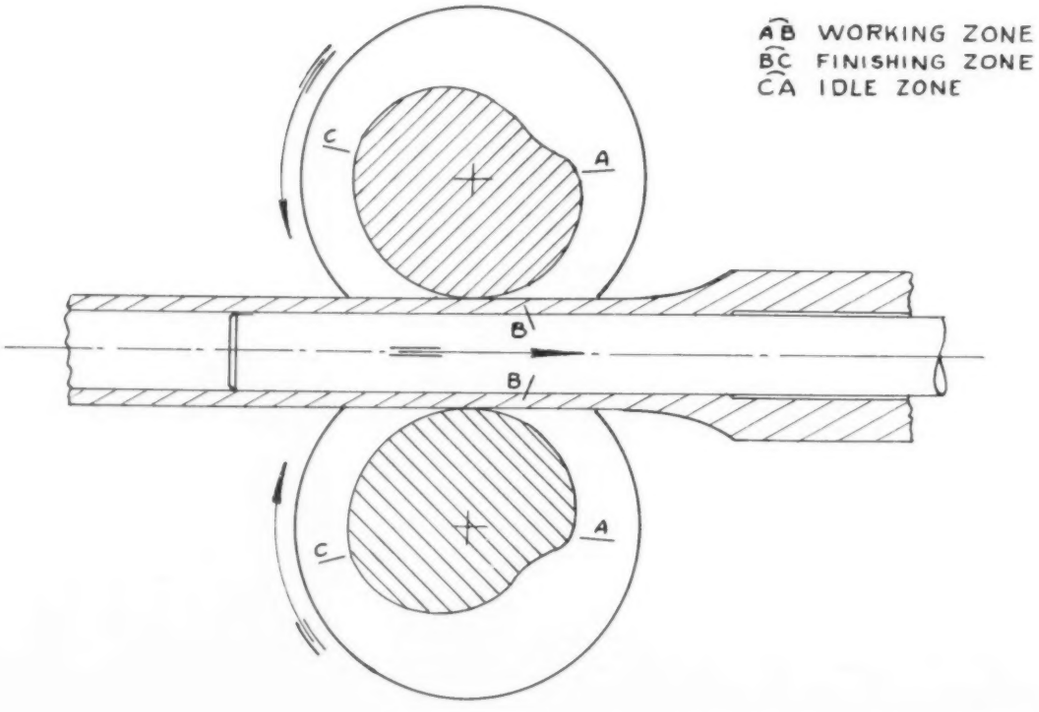


Figure 17 — Sketch shows finishing zone of mill doing the work.

air pressure is adjusted for one size pipe, this control needs very little attention.

The mandrel bars are from 15 to 16 ft long and they are tapered approximately $\frac{1}{16}$ in. in their total length. Approximately five mandrel bars are used at a time. While one is used as the working piece, the others are allowed to air cool and then dropped into water for further cooling. Approximately three mandrel bars are air-cooling and one is cooling in water. There is a complete cycle in this operation.

The elevation of the bottom roll is fixed and for each size of pipe its heighth is adjustable. The top roll must be elevated after each piece as when the pipe is rolled, a bell is formed. The top roll is held up against the screw, by hydraulic pressure. The rolls are raised and lowered by an electric motor. Since the mandrel bar is tapered approximately $\frac{1}{16}$ in. in its length, and in order to keep the wall thickness constant, there is an inching device for raising the rolls during rolling. The inching device consists of a separate motor and a large reduction gear which is attached through an air-clutch to the same shaft as the main screwdown motor. As the pipe is being forged over the mandrel, the operator inches the top roll up in order to compensate for the taper on the mandrel bar and its expansion due to the heat.

From the figures showing the forging process, notice that the direction of the main flow of metal is in the same direction as the feed, and that the mandrel bar is rotated approximately 90 degrees with each revolution of the roll. As the pipe is forged and flows forward over the mandrel, it slides onto a trough. As the hollow bloom is completely forged into a pipe, the mill is opened and retractable rollers are raised, which transport the pipe to the hot saw where the forward crop end and the bell are cut off. The pipe is then measured and weighed. The foreman uses this measurement and weight as a check on his wall thickness. There is on order X-ray equipment with which the wall thickness can be checked as the pipe leaves the mandrel bar. This will allow the operator to compensate immediately if there is any error in roll setting.

From the scale the pipe is conveyed through a radiant heat reheat furnace where the pipe is brought up to temperature for sizing. A five-stand sizing mill is located at the exit of the reheat furnace. Three of these stands are motor driven. The motor driven rolls rotate in a vertical plane and the two sets of idler rolls rotate in a horizontal plane. The sizing mill is capable of almost 1-in. reduction in diameter on the large sizes. After leaving the sizing mill, the pipe is conveyed to what is called a polishing mill. This mill has two driven rolls of the Calmes design and one smaller idler roll. Just enough reduction is made in this mill, so that the rolls will bite the material putting on a smooth finish and also straightening the pipe. There was a hot cross roll straightener in the line but it is not used as the polishing mill does a much better job. The pipe is then conveyed to cooling beds where it is cooled before entering the finishing department, where it is inspected and tested. After passing through a painting machine and onto scales, it is then ready for shipping.

Discussion

PRESENTED BY

CLYDE A. ROBERTS, Chief Engineer, Phoenix Iron and Steel Co., Phoenixville, Pa.

A. L. THURMAN, Executive Vice President, Mannesmann-Meer Engineering and Construction Co., Easton, Pa.

JOHN P. D. GERRESE, Chief Engineer, National Tube Div., United States Steel Corp., Gary, Ind.

PAUL E. FLAUTZ, Division Superintendent, Tube Mills, Pittsburgh Steel Co., Allenport, Pa.

RAYMOND L. CAREY, Assistant Chief Engineer, Taylor-Wilson Manufacturing Co., Pittsburgh, Pa.

A. B. CAPRON, Chief Engineer, Tubular Products Div., Babcock & Wilcox Co., Beaver Falls, Pa.

Member: Would you care to discuss yield possibilities and tonnage capacities of your mill?

Clyde A. Roberts: The yield on the mill is approximately 85 per cent. This is taken from the cast ingot to the shipped pipe.

A. L. Thurman: We in the seamless tube industry are indebted to the authors for the fine presentation they have made on the technical features of a very interesting method for producing seamless steel tubing. Of course the Mannesmann pilger mill has been used for some time in Europe as this mill suits their frequent changes in rolling schedules.

Following the invention of the assel mill, an elongator with three driven rolls which produces a very good, concentric tube, Dr. Calmes conceived the idea that it might be possible to obtain the same results on a mill with two driven rolls; this resulted in the Calmes elongator which was developed while Dr. Calmes worked for Mannesmann in Germany. The Calmes elongator is still in use in one of the Mannesmann plants, but its limited use in the Mannesmann organization has been due to the high cost of conditioning the ingot and the later reconditioning of the shell as it emerges from the elongator, or if the shell is not reconditioned at that point, additional grinding is generally required for removal of the fins on the finished tubes.

In Germany, in order to obtain a satisfactory product with the Calmes mill, this extra conditioning has been found to be necessary. Examination of the Phoenix roll contour will indicate that it is very similar to the conventional Mannesmann pilger piercing mill roll contour, which is apparently the reason their mill does produce a high quality seamless tube without extra conditioning. Another worthwhile development of the Phoenix piercing process is the ability to roll a range of sizes from 6 to 16 in. without a change of rolls.

In addition to the data supplied by the authors it would also be of interest to have some data on the hot mill yield, the rate of production and the production pattern of the mill at Phoenixville; to hear something about the tolerances the mill is able to produce on a given size tube would also be interesting.

Besides the contributions the authors and the operators have made to the success of this mill, the seamless tube industry in this country also owes a vote of thanks to the management of the Phoenix Iron and Steel

Co. for their foresight in planning the installation of a Mannesmann pilger mill, especially after this method of production had been virtually abandoned in this country. It is true that this process does have a limited application in the USA, but, as demonstrated by this installation, it does very capably meet the requirements for the production of heavy walled and specialty tubing, where frequent schedule changes are necessary. The ability of the Mannesmann pilger mill to provide a finished seamless tube from an ingot without intermediate rolling, as so capably illustrated by the authors, is also an outstanding advantage of this mill. Again it is a pleasure to congratulate the authors for an excellent presentation of an interesting subject.

Clyde A. Roberts: The hot mill yield is 90 per cent and this includes the losses due to scarfing. The rate of production varies considerably due to the diameter and length of the ingot.

The mill produces heavy wall tubes and pipe to very close tolerances. We always try for a tolerance of plus or minus $\frac{1}{32}$ in. wall thickness. Although we do not always achieve this, we are always well within the limits allowed by the ASTM A-106 Specification.

The mill was designed to scarf the hollow bloom on certain specifications of pipe. We were actually going to have two passes through the elongator, but we found by conditioning the ingots in the beginning, that the two passes in the elongator and the scarfing of the hollow blooms was not necessary. If we start off with a perfect ingot, we do not have any trouble.

John P. D. Gerrese: The paper mentioned the use of tapered mandrel bars. The taper I believe was $\frac{1}{16}$ in. I would like to know how you machine the taper on that bar.

Clyde A. Roberts: We have a lathe set up with an offset head which allows us to get the $\frac{1}{16}$ in. taper on the mandrel bar.

John P. D. Gerrese: Do you have the taper cut the entire length of the mandrel?

Clyde A. Roberts: Yes, for fourteen to sixteen feet, depending upon the length of the mandrel.

Paul E. Flautz: The power vs. metal displacement curves as portrayed for the three roll passes, namely the Phoenix, Calmes, and Mannesmann, indicate that the phoenix pass is most efficient; but no mention is made of billet feed rate or rate of metal displacement per unit time. Was this rate equal for all three passes?

Clyde A. Roberts: The Phoenix roll has a greater average feed speed than the Mannesmann or Calmes, and consequently a greater cubic inch per second displacement. Originally, we operated the elongator with the rolls set at an angle of 4 degrees–10 minutes. In order to cut down on the power peaks and also to obtain a better surface in the hollow bloom, we changed the angle of inclination to 3 degrees. The following table shows the relationship between these values for the 3-degree inclination.

Roll type	*Average feed rate, in. per sec*	*Average displacement cu in. per sec*
Mannesmann	1.27	50.5
Calmes	1.72	83.5
Phoenix	1.82	94.4

The speed for the Mannesmann roll has taken an average of five measurements, the Calmes roll for about seven measurements, and the Phoenix roll an average of ten measurements.

Paul E. Flautz: One discusser asked about ultimate yields and I would like to further his question. Conventionally, for all previous pilger mills in this country, round ingots were pierced by a Mannesmann roll piercer. Has the extrusion of corrugated ingots instead of roll piercing round ingots resulted in higher finished tube yields?

Clyde A. Roberts: Yes. Although we have not had the personal experience. We definitely feel that we had a higher yield.

Raymond L. Carey: I noticed that you put all your pipe through a hot saw. What wall thicknesses do you put through the saw?

Clyde A. Roberts: We put all sizes through the hot saw and the majority of the pieces vary from $\frac{1}{2}$ to $2\frac{1}{2}$ in. wall thickness.

Raymond L. Carey: Do you get a perfect cut on the hot saw in the $\frac{1}{4}$- to $\frac{1}{2}$-in. wall thickness range?

Clyde A. Roberts: We do not get a perfect cut, however, all our pipe goes through the cutoff machine in the finishing department.

A. B. Capron: I would like to ask Mr. Roberts what is the ratio of elongation from the elongated hollow to the pilgered tube. It appeared that he had a pretty heavy bite on the pilger mill, and I wondered what the average elongation usually is on a fairly thin-walled tube.

Clyde A. Roberts: I do not know whether I can say what the average is, but in the pilger mill we can go as high as 9 or 10. The average is considerably below that, and it is the same way with the average in the elongator. We try to keep it below five. The average is below that.

A. B. Capron: What is the maximum length of your tubes out of the pilger mill?

Clyde A. Roberts: The maximum length of tube that can be produced is determined by the weight of the ingot and the length of the hollow bloom entering the rotary forging mill. We have actually made a pipe 65 ft long, but we try to hold the maximum length to approximately 55 ft, so as to have a maximum shipping length of 50 ft. ▲

There is a constant demand for copies of "The Modern Strip Mill" published by the Association of Iron and Steel Engineers.

If your copy is not in use please get in touch with us.

ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

European Steelmaking Today

Figure 1 — The Ebbw Vale works of Richard Thomas & Baldwins Ltd. started up in 1938.

. . . . since the war practically every country in Europe has made strenuous efforts to build up its iron and steelmaking capacities and to modernize plants . . . . emphasis has been aimed at continuous operation . . .

by ALASTAIR McLEOD*
Editorial Director-Technical,
Industrial Newspapers, Ltd.,
Adelphi,
London, England

SYNOPSIS

THE tremendous upsurge in the demand for steel in Europe was foreseen prior to the war, but hostilities prevented any of the development plans being put into action. With the return of peace, and the advent of large-scale manufacturing and rebuilding programs, this demand even exceeded expectations, with the result that steelworks all over Europe swiftly acquired new plant, and demanded higher output—in quality and quantity—from equipment already in use. One development program successfully followed another, with the result that the output of Western Europe (E.C.S.C) steelworks rose from 37,600,000 net tons in 1937 to 57,800,000 net tons in 1955. In the same period production of crude steel in the United Kingdom rose from 14,300,000 to 22,100,000 net tons. These figures indicate that the industry in the European area is very active, in plant design and operation, process mechanization (or automation—to use the modern word) and metallurgical enterprise.

Development schemes have not always been easy to implement; the ideal green field site has been infrequently available, and with the over-all need to maintain production, considerable engineering skill had always to be available for installation work in plants continuously in production.

Notable in recent years has been the advent of the European Coal & Steel Community, linking France, Saar, Belgium, Germany, Italy, Luxembourg and

* Deceased.

Holland in these industries. The economic structure of this body, and the general scope of its activities are discussed. Advances in plant design, to produce not only the increased output that is continually in demand, but also to absorb the steady flow of research and development information are described.

Does it always happen that mid-century periods are of crucial importance in world history? When preparing this paper, the idea did occur, possibly sharpened by the thought of the Bessemer and Gilchrist Thomas commemorative lectures and articles. The continually increasing demand for steel has also given rise to so much development work all over the world at this time that engineers and metallurgists also look forward to a new era in their craft. Even as these words are being written, news is continually arriving of new developments in the European steel industry—extensions to existing plant, installation of new equipment, production targets being achieved and raised, and the restless pursuit by research teams of improved quality and output. It has been publicly stated by many leading authorities that no slackening of the demand for steel is at present envisaged. The pattern of the market may change, as for example in the current demand for plates, but the picture is one of increased over-all tonnages available, along with plans for steady growth and expansion of the industry throughout the area.

The work of Bessemer is so topical that a brief historical note may not be out of place in opening this paper, particularly as his centenary comes into the period at present under review. A large number of articles and papers[1,2,3,4]* have been written to mark this centenary, and many new thoughts are engendered by reading them. Carnegie's noble words[5] come instantly to mind:

> "Rest easy 'Great King of Steel,' and smile on all attempts to rob you of immortality and the gratitude of the world."

It was in a modest paper "The Manufacture of Malleable Iron and Steel without Fuel," presented at a meeting of the British Association for the Advancement of Science, that first announcement of the process was made. The first patent had been registered in January 1851, reporting that he had tried to improve pig iron by adding wrought iron to it. Many further patents followed, and finally he filed the patent of 1856, in which he proposed the fitting of several tuyeres into the bottom and blowing with cold air (steam not being excluded), in a kind of oscillating converter, roughly pear-shaped.

Now, a century later, converter steelmaking has assumed immense importance, and it may be said that basic bessemer steel is the basis of the heavy steel industry in Europe. The acid-bessemer process is mainly used in continental Europe by small steel foundries, but there is one notable plant (Workington) employing the process in Great Britain. These latter works, in West Cumberland, have been associated with the acid process from the earliest days when Bessemer was striving to overcome his initial difficulties.

In the course of this paper, reference will be made to the vast amount of research work now under way, all making a valuable contribution to the advancement of the iron and steel industry, but the work of Bessemer and his collaborators will never be overshadowed.

In this period, too, the centenary of William Kelly is to be celebrated. Doubtless this will revive old controversies, in which it is not the purpose of the present author to join. Rather would he pay sincere tribute to pioneers in the industry, which has become by far the most important in the world.

NATIONAL DEVELOPMENT

To the student of international affairs there is considerable interest in the methods adopted by individual European countries for the advancement of iron and steel production. Every nation was, of course, profoundly affected by the war and its aftermath, some by damage and dismantling, others by uncertain potential demand, still others by politics, and all by impoverishment. It is not, therefore, possible to describe under one "umbrella" the over-all reequipment and development of the European steel industry. A clearer result will, it is hoped, be achieved by treating each country separately, giving the pattern of progress in each case and the means whereby output tonnages and quality have been improved.

The over-all effect of the European Coal and Steel Community has been left to the end of this section, since each country is responsible for devising its own proposals before submitting them to the High Authority.

GREAT BRITAIN

The first development plan in Great Britain was prepared by the industry in 1945 and presented to the Government in 1946, and co-ordinated many large-scale individual schemes, some of which had been inaugurated over 15 years previously. While the initiative for these separate plans came from the firms concerned, it soon became apparent that co-operation and exchange of ideas throughout the industry would avoid duplication in the various schemes envisaged and yield profitable results much more speedily. This first plan, prepared by the British Iron & Steel Federation, was designed to make 16,500,000 net ingot tons to cover the industry's requirements until 1952. Thus, by 1949[6] it was possible to report that two-thirds of the first Development Plan was complete (despite all the difficulties of that period), and that output in 1948 amounted to 16,365,000 net tons. Amongst the new plant installed by that date were ore unloading and treatment plant at Dorman Longs, ore preparation plant at Corby, coke ovens at Consett, blast furnaces at Consett, Clyde Ironworks and Margam, and a new melting shop at Appleby-Frodingham.

With the ever-growing demand for steel, it became increasingly evident by 1952 that still further development would be required, so that plans for the period 1953–58 were next announced. These were advanced more as a continuous process of development than as a second edition of the first plan. Provision was thus made for the significant changes which have taken place since 1952, both in the pattern of demand and in the means of satisfying it.

These plans, published in a report by the Iron &

* Numbers refer to Bibliography at end of paper.

Steel Board[7], reviewed the increase in the demand for steel to be envisaged in the years to 1958 and described what was being done to meet it. The conclusion was that demand could be estimated at approximately 24,750,000 net ingot tons by the end of that period, but this figure was advanced later to 25,950,000 net tons. Significantly, it was observed in the reports of that period that the need for still further expansion would be kept under review, an attitude that has contributed in no small measure to the smoothness with which the plans announced in the 1957 report have dovetailed into those already made.

Among the problems under review at the commencement of the second period mentioned were further development in the use of home ore, the further modernization of existing plants, the possibility of expanded production of billets and flat-rolled products, and improvements in the alloy steel production.

PLANT COMPLETED 1953–58

With little or no disturbance in the rhythm of production, considerable plant extensions were made in this second period; the additions, indeed, were so extensive in some cases that new plants seemed to have come into being. In the case of The Steel Company of Wales Ltd., for example, a plant was built under and over an existing works—a major engineering feat,[8] and the same applies to Consett Iron Co. Ltd.[9] In this period, too, The Steel Company of Wales Ltd., commenced production in two brand-new tinplate plants—Trostre and Velindre—jointly producing nearly one-half of the national output of this material.

Only the principal items of the extensions made all over the country can be mentioned.

Stewarts and Lloyds Ltd. started up a new plug mill with a capacity of 88,000 net tons per year at Corby, a 21 ft-6 in. hearth diameter blast furnace to increase pig iron production by 99,000 tons per year at Bilston, and a new tube mill at Clydesdale. New blast furnaces were installed at Lancashire Steel Corp. (two of 21 ft-6 in. diameter); John Summers & Sons Ltd. (one of 27 ft-0 in. diameter); Appleby-Frodingham Steel Co. (two of 27 ft-0 in. and 28 ft-6 in. diameter respectively); Dorman Long (Steel) Ltd. (two of 27 ft-6 in. diameter); South Durham Steel & Iron Co. Ltd. (two); Cargo Fleet Works (one); Colvilles Ltd. (one of 25 ft-6 in. diameter); and Steel Company of Wales Ltd. (one of 29 ft-9 in. diameter).

Space does not permit even the listing of all the ancillary plant that has been installed to increase produc-

Figure 2 — Dorman Long built a universal beam mill on this site. This construction is typical of what has been going on throughout Europe.

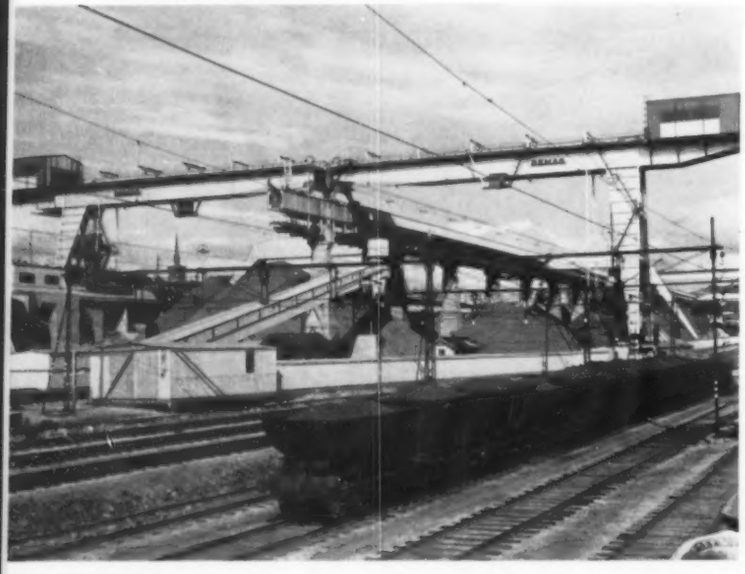
Figure 3 — Walking dragline strips overburden from ironstone pit for Stewarts and Lloyds Ltd. Corby works, Bucket handles 27 tons.

tivity in the various plants, but attention might be directed to the completion of some individual development schemes, particularly as some of them have been very fully described, both in design and operation, elsewhere. The ingot output at the Hawarden Bridge Steelworks of John Summers & Sons Ltd.[10] now exceeds 1,375,000 net tons, and flat rolled products 935,000 net tons per year.

The "Seraphim" project of Appleby-Fordingham Steel Co.[11] is world famous, and is notable as being designed to permit the use of 100 per cent sinter burden to secure economical working with the low-grade Lincolnshire and Northamptonshire ironstones.

Colvilles Ltd. have now completed the first stage of the building and equipping of the new "green field" Ravenscraig plant,[12] and the next stage of this development scheme has already been announced, proposing the further expenditure of £32,000,000. The coke ovens were lit on June 3, 1957, the blast furnace commenced production on August 2, and steelmaking was started on August 18.

Figure 4 — Largest ore handling installation in Europe is at A/S Norsk Jernverk at Narvik, Norway. Plant is capable of handling 8000 tons of ore per hr.



The second stage of The Steel Company of Wales' scheme included a 29 ft-9 in. hearth diameter blast furnace, claimed to be the largest outside the United States.

Samuel Fox & Co. Ltd. are installing an additional electric arc furnace, to be completed early in 1958. A combined bar and rod mill is also being installed at these works.

SUMMARY—1953–58 PERIOD

Summarizing at this point, it will (it is hoped) be clear that the second stage of advancement has included a "green field" plant only where absolutely necessary and justified. In the result, such new plants have gone into operation smoothly and efficiently, and they embody the latest features known to iron and steel engineers. The problems attaching to the extensions and improvements made to existing plants have also provided technical staffs with wonderful opportunities, the success of their efforts being reflected in the output figures achieved.

Crude Steel Production

1946	14,000,000 net tons
1956	22,700,000 net tons

THE PRESENT AND THE FUTURE

The foregoing data provides the background to the present position and future prospects for steel production in Britain.[13] The carefully laid plans for increasing output are steadily naturing as is evidenced by the latest figures available at the time of writing (Table I).

TABLE I
Steel Ingots and Castings (Net Tons)

	1956		1957	
	Weekly average	Annual rate	Weekly average	Annual rate
April	470,000	24,500,000	480,000	25,000,000
May	443,000	23,000,000	495,000	25,800,000
June	424,000	22,000,000	467,000	24,400,000
Half year	455,000	23,700,000	480,000	24,900,000

Consideration may therefore now be given to the period to 1962. It is confidently anticipated that in the light of development proposals approved by the Board there will be sufficient capacity available for the production of 32,400,000 net ingot tons by that year.

There are, however, important plans still to be finalized, the principal one being concerned with the works of the Richard Thomas & Baldwins group. This scheme will include some increase in output at Ebbw Vale, but its main feature is the construction of a new integrated steelworks on a new site at Newport, which in its first stage will include two blast furnaces and two melting shops, one using the open-hearth and the other the oxygen-blown bessemer process. The existence of the new works will obviate the necessity for bringing slabs

to Ebbw Vale from Redbourn which will thus be able to concentrate wholly on billet production. The new works will also replace steel for Ebbw Vale at present drawn from old plant in West Wales, which will gradually be retired. This new plant will be capable of considerable development as and when conditions and circumstances permit. It might well form the base to which another wide strip mill, with associated cold reduction and finishing capacity, could be added; and even further development in any one of a number of directions could be pursued at a later stage.

In general, it can be said that blast furnace capacity is being expanded more than proportionately to provide for the expected scrap situation. The principal individual iron and steelmaking schemes (additional to those already in being) to be finalized by 1962 are listed below. These will be noted as well-dispersed throughout the country, while the steady adoption of new techniques will be apparent:

New blast furnaces
- Bairds & Scottish Steel Ltd. (two furnaces and one additional battery of coke ovens).
- Colvilles Ltd. (second furnace at Ravenscraig and one additional battery of coke ovens).
- Consett Iron Co. Ltd. (fourth furnace and one additional battery of coke ovens).
- John Lysaght's Scunthorpe Works Ltd. (one blast furnace and one additional battery of coke ovens).
- South Durham Steel & Iron Co. Ltd. (West Hartlepool—one blast furnace and two additional batteries of coke ovens).
- The Steel Company of Wales Ltd. (fifth furnace and one additional battery of coke ovens).
- Richard Thomas & Baldwins Ltd. (two furnaces and one additional battery of coke ovens).

New melting shops
- Wm. Beardmore & Co. Ltd. (electric arc furnaces).
- Brymbo Steelworks Ltd. (electric arc furnaces).
- Consett Iron Co. Ltd. (steam/oxygen-blown basic bessemer converters)
- English Steel Corp. Ltd. (open hearth furnaces).
- South Durham Steel & Iron Co. Ltd. (open hearth furnaces).
- The Steel Co. of Wales Ltd. (steam/oxygen-blown basic bessemer converters).
- Richard Thomas & Baldwins Ltd. [(a) open hearth furnaces, and (b) steam/oxygen-blown bessemer converters].

Again the pattern of demand has been carefully studied and will be continually under review. Thus, for example, new plate mills are under construction at Appleby-Frodingham and Patent Shaft & Axletree Co. Ltd., while additional plate mills are being laid down by Colvilles Ltd., Consett Iron Co. Ltd., and South Durham Steel & Iron Co. Ltd. All flat rolled products are receiving particular attention in the expansion program, also billets, alloy steels and heavy forgings.

To increase productivity and still further reduce costs, operating practice is continually under review, the continually expanding use of oxygen being of particular importance. It is believed that the next five years will see even more widespread use of tonnage oxygen for steelmaking, the main potential uses being

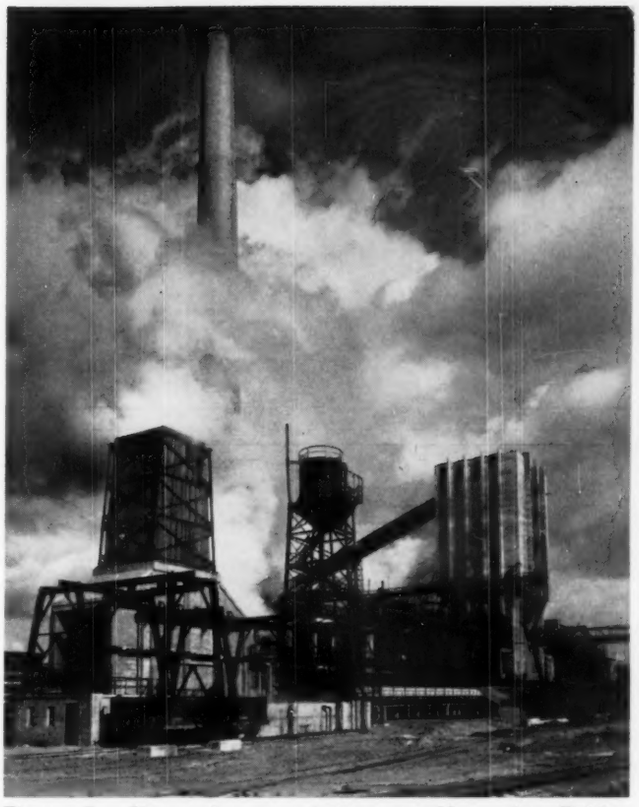


Figure 5 — New coke oven battery at Hawarden Bridge Works of John Summers & Sons Ltd.

for prerefining of iron, oxygen/steam blowing of bessemer converters, extension of oxygen lance methods, and admixture of oxygen to speed combustion. The general subject of oxygen is dealt with in greater detail later in the paper.

The substitution of continuous rolling for the older hand mills is not a new development, but as in USA it has considerable importance in Britain. Ebbw Vale, Shotton and Margam between them account for three-quarters of the sheet production, but the remaining laboriously produced output is still necessary and is only slowly being made obsolete.

Imported ore is so important that everything possible has naturally been done to speed up ore-unloading by the provision of high-capacity unloaders and new large ore carriers. The normal unloading time for 6000 tons of ore has fallen from 1100 man-hours to 670 man-hours, and even this performance has been improved.

Considerable improvements in blast furnace productivity are expected, particularly by means of the further development of ore crushing and grading and the increase in sinter capacity. Sinter production in 1950 was 3,800,000 net tons and consumption in blast furnaces was equivalent to nearly 700 lb per net ton of iron. In 1956, production was 8,650,000 net tons with a consumption equivalent to about 1200 lb per net ton of iron. More substantial increases in sinter capacity are planned, and production in 1958 should be between 12 and 13,000,000 net tons, making possible a further increase in the use of sinter to about 1400 lb per net ton of iron. By 1962, sinter production may be about 19,000,000 net tons, and the use of sinter may rise to 1700 lb per ton of iron—roughly 2½ times the 1950 level.

As for the latest over-all picture of steelmaking in Britain, the most general process in use is the open-

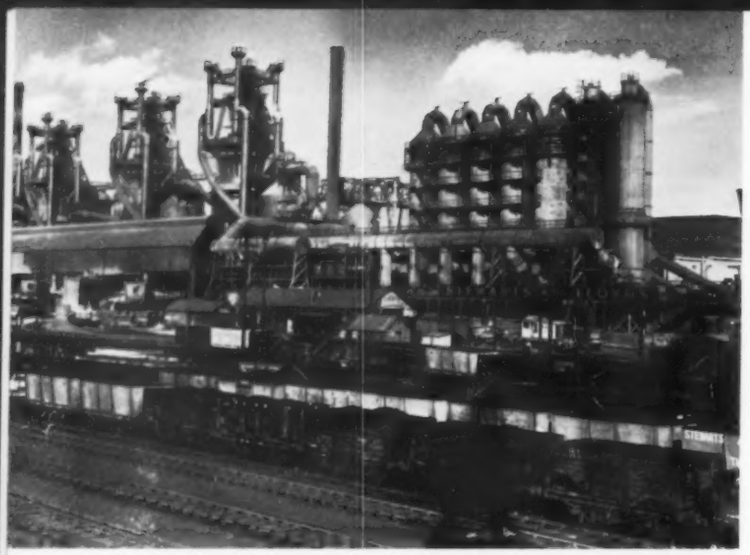


Figure 6 — This typical modern British blast furnace plant smelts low grade ores.

Figure 7 — No. 4 blast furnace at IJmuiden, Holland is a 27 ft-10 in. hearth diameter.

Figure 8 — Frame and skip track on this blast furnace at Eisenwerke Mulheim-Meiderich are of plate girder construction.

hearth, approximately 87 per cent of the total production being by means of this method. The bessemer process produces 6½ per cent, electric furnaces account for 6 per cent, and all other methods supply the remaining ½ per cent. The advent of oxygen in conjunction with the bessemer will materially alter this picture, the new bessemer shops to be erected at Margam and Consett being expected to increase by 1962 the proportion of bessemer steel to about 10 per cent of total production. Even as these words are being written, the first plant items for this purpose are arriving at Margam.

While it will not always be possible to install larger furnaces in existing plants, the tendency is certainly for furnace size to increase, examples being 45/55-ton converters for the bessemer, open-hearth furnace size to increase from the recommended minimum (170 tons for fixed furnaces for cold metal, and 250 tons tilting furnaces for hot metal); while the latest electric furnaces will be of 70/90 tons capacity.

Finally, mention at least must be made of automation. The word has become very fashionable in recent years, and although first thought would apply it to the repetition or mass-production processes, there is a considerable and important future for further mechanization in the iron and steel industry. Mechanical actions, human judgment, and the element of decision can already be replaced to a certain extent by control instruments, but the scope for development is wide, embracing the blast furnace, the open-hearth and the recording on punched tape of plant operation data which can thus be analyzed immediately by digital computers.

FRANCE

The objectives for the French iron and steel industry as stated by the Iron & Steel Modernization committee in 1947 were as follows: (1) to overhaul and modernize productive capacity, which had not been fully utilized since the depression of the early 1930's; (2) to adapt production to the changing pattern of demand, in particular by the construction of two continuous wide strip mills; (3) to reduce coke consumption by the extension of ore preparation; and (4) to modernize such ancillary installations as power stations and coking plant. In the ensuing years much of this work was accomplished, and in particular results were achieved in the improvement of ore preparation and beneficiation and in reducing coke consumption. Of the new plant installed, the largest blast furnace had a hearth diameter of 21 to 22 ft with a daily capacity of over 600 tons; new and larger open hearth and electric furnaces and basic bessemer converters were installed, while attention was also paid to improving the quality of basic bessemer steel, which accounts for some 60 per cent of French production. Notable also were the installations of two continuous wide strip mills, one in Northern France and one in Lorraine.

Crude steel output did not expand in the manner expected, however, and in 1952 was under 12,000,000 net tons, against the 1952/53 target of 13,800,000 net tons. While this scheme was being brought to fruition, French steelmakers began talks on a vast new 7-year expansion plan to raise the combined capacity of the French and Saar steel industries to 23,200,000 net tons per annum by 1960.

At the same time the French government was preparing its own second modernization plan, designed not only to embrace the basic industries but also to cover finishing. A report on this second plan was published by the Iron and Steel Modernization Committee of the Planning Commission. This sets out the main objectives for France up to this year and assumes that an output of 15,700,000 net tons of crude steel should be sufficient to satisfy home and export requirements. The committee have found it necessary to fix these objectives in accordance with the conditions resulting from the establishment of the European Coal & Steel Community; they state that the industry's essential aims will be "To strengthen its competitive position on the common market, to reduce its production costs, and to improve the quality of its products—particularly of basic bessemer steel." Expansion of output was also implicit in the plan. Table II gives details of the blast furnace work in operation, while Table III deals with open-hearth and electric furnaces.

Close liaison has been maintained between the modernization committee and the French iron and steel companies, who were asked to submit their individual development plans. As a result, the companies envisaged construction of seven new coke oven batteries, including five in Lorraine (totalling 174 ovens) and two

TABLE II
French Blast Furnace Plans

	New Furnaces		Furnaces to be rebuilt	
	Number	Capacity thousand tons per annum, net	Number	Capacity thousand tons per annum, net
Integrated works (producing basic bessemer pig iron) under construction Jan. 1, 1954	6	1280	3	550
New projects	8	1730	16	2360
Other works under construction Jan. 1, 1954	2	330	7	660
New projects	1	90	11	1070
Total	17	3430	37	4640

TABLE III
New Open-hearth and Electric Furnaces Planned—France

	Open-hearth		Electric	
	Number	Capacity, thousand tons per annum, net	Number	Capacity, thousand tons per annum, net
Integrated works				
Under construction Jan. 1, 1954	3	240	1	30
New projects	11	820	1	20
Non-integrated works				
Under construction Jan. 1, 1954	1	40	..	..
New projects	5	310	1	10
Works in Central and Southern France				
Under construction Jan. 1, 1954	..	..	2	60
New projects	1	80	6	110
Total	21	1490	11	220

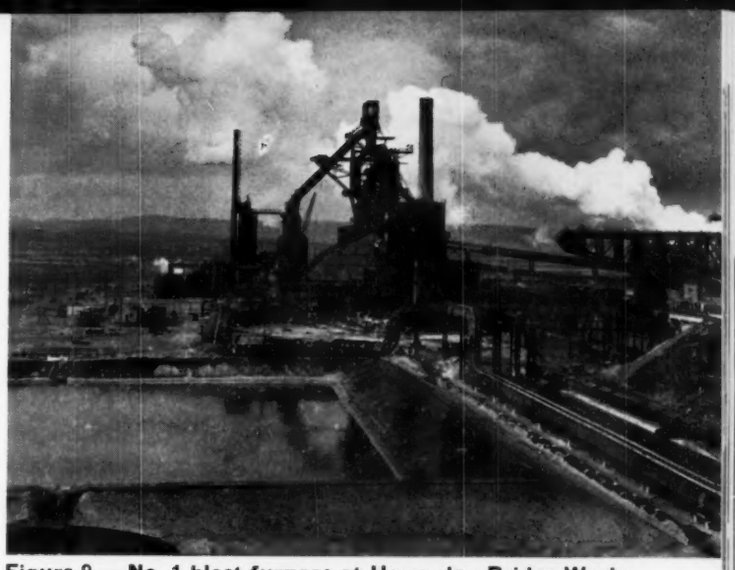


Figure 9 — No. 1 blast furnace at Hawarden Bridge Works of John Summers & Sons Ltd. has a 27-ft diam hearth.

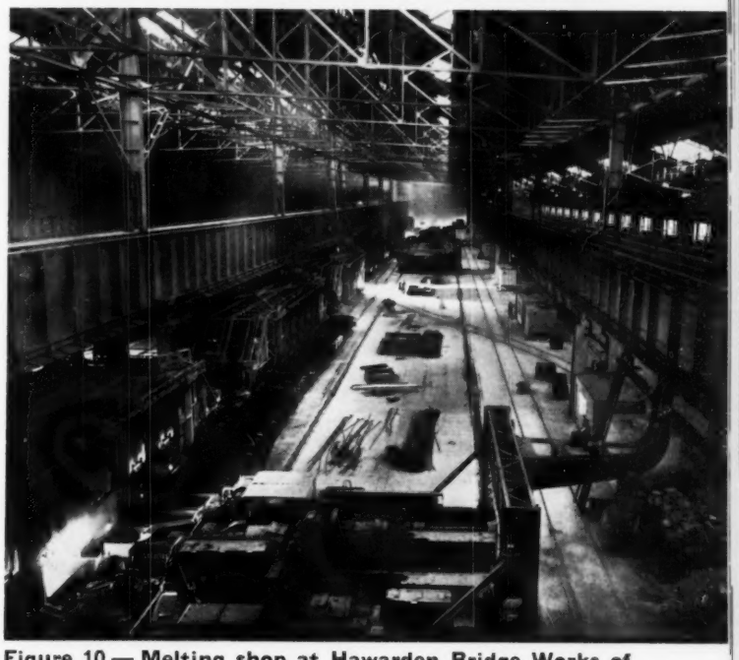


Figure 10 — Melting shop at Hawarden Bridge Works of John Summers & Sons Ltd.

Figure 11 — Casting bay shown is at Abbey works of the Steel Company of Wales Ltd.

in coastal plants (52 ovens); this was in addition to one new coking plant and four new batteries (147 ovens), all in Lorraine, which were already under construction at the beginning of 1954. These ovens represent a total capacity of 1,650,000 net tons annually. The companies also planned to raise production of sinter at integrated steelworks from about 1,100,000 net tons in 1952 (in five plants) to 4,600,000 net tons in 1958 (in 12 plants). The committee felt that no modification was needed to any of these projects.

As regards basic bessemer steel, the companies planned the construction of one new melting shop (two replace obsolete plant) and the complete reconstruction of another shop; the installation of eight mixers and six converters; the extension of two oxygen-producing plants already operating, and the construction of four entirely new oxygen plants. This was in addition to the projects already under way at the beginning of 1954, which included completion of a new basic bessemer shop with an oxygen producing plant to serve four neighboring works, and installation of two mixers.

The Iron and Steel Modernization Committee believe that when the foregoing projects are completed at an estimated cost of £225,000,000, it should be possible to produce 15,800,000 tons of crude steel (in addition to 2,650,000 tons of non-steelmaking pig iron) by the end of this year. Provision is made for still further production increases, but the possibility of these, and indeed the realization of present objectives, depends on such factors as raw material supplies, availability of finance, and growth in demand, which latter is inextricably bound up with the ECSC common market.

HOLLAND

Principal interest in the development of the iron and steel industry in Holland naturally centres on Koninklijke Nederlandsche Hoogovens en Staalfabrieken n.v. ("Hoogovens"), at IJmuiden. These works were started by the erection of two blast furnaces and a coke oven plant in January, 1924. A third blast furnace followed and a period of steady expansion ensued. Considerable war damage was suffered, but on the cessation of hostilities, damage to the plant was quickly repaired; the plate mill was reconstructed, the capacities of the coke oven plant, blast furnaces and steel plant were increased, and the decision was taken to build a semi-continuous 56-in. wide strip mill. For this latter venture a new company was formed, known as Breedband. At the same time Hoogovens again increased the steel capacity and built a 112-in. blooming and slabbing mill. The whole works were in full operation at the official opening of Breedband on June 25, 1953.

This quick and important development in Dutch national economy took place on the basis of the strength which the company had shown in its competitive power. The works occupy a magnificent site on the North Sea and at the mouth of the system of rivers and canals which link it to the central parts of Western Europe. The favorable position of the deep water site, with berths for sea-going vessels, permits transport costs of imported ore to be kept low and also assists export of products. The ore imported is 30 per cent Swedish, 30 per cent North African, 15 per cent Normandy, 10 per cent Spanish and Spanish Morocco, and 15 per cent Brazilian.

Figure 12 — Pouring 1100-ton mixer at Consett Iron Co. Ltd. plant.

Table IV gives the production figures for both Hoogovens and Breedband in 1956.

Further extensions have now to be recorded. The coking plant has been modernized and by the construction of two new coke oven batteries enlarged to five batteries. A sixth open-hearth furnace in the steel melting shop and a new ore-sintering plant commenced production in November 1956.

Other expansion plans announced recently include the erection of a fourth blast furnace and of a second steelworks, as well as the construction of a new electrolytic tinning line. After completion of these extensions, by the beginning of 1958, the production of pig iron will reach a figure of 1,100,000 net tons and that of crude steel 1,210,000 net tons per annum.

The complete description of the development of both the Hoogovens and Breedband works has been given as a Presidential Address by Mr. A. H. Ingen Housz to the British Iron & Steel Institute. In that paper is also described the background to the research now taking place at IJmuiden on flame radiation, in which the United Kingdom, France, Belgium, Luxembourg, USA and Sweden all participate, while the European Coal & Steel Community has made a financial grant. The conversion to all-basic furnaces is also discussed.

TABLE IV
Production at IJmuiden Works, 1956

Hoogovens		
Pig iron	733,000 net tons	3 Blast furnaces
Crude steel	788,000 net tons	6 Open-hearth furnaces
Steel plates	286,000 net tons	Plate mill
Breedband		
Hot rolled sheets	33,000 net tons	Hot strip mill
Cold reduced sheets	260,000 net tons	Cold finishing mill
Tinplate	74,000 net tons	Tinplate plant

SWITZERLAND

High production costs preclude Switzerland from producing sufficient steel to cover her domestic requirements and imports will therefore always be important. Further entry into the steel industry has frequently appeared to have advantages, but the idea has always been rejected because of the meagre raw material sources available. Nevertheless, although the Swiss population is less than 5,000,000, implying a restricted home market the country has become one of the most highly industrialized areas of Europe, only the United Kingdom and Belgium being relatively more intensified. For the highly-developed metal and engineering industries, annual steel requirements are now well over 550,000 tons, of which slightly over one-quarter is produced at home, the remainder being imported.

Water power is practically the only natural asset possessed in abundance by Switzerland, and it is therefore not surprising that both pig iron and crude steel output now come entirely from electric furnaces. Electricity supplies (over 95 per cent of which are from hydroelectric plants) were greatly increased both during and since the war, and installed capacity is now about 3,000,000 kw. But this source of power is not always available to the full.

There are three ingot steelmakers in Switzerland, Gesellschaft der Ludwig von Rollschen; A.G. der von Moos'chen Eisenwerke; and the Monteforno Acciarie e Laminatoi; the latest output figures are 220,000 net tons of ingots per year (Communicated by Dr. Durrer).

A full description of the von Rollschen works was given by Prof. Dr. Durrer to the Iron & Steel Institute during their first foreign visit (to that country) after the war, and appears in the proceedings of that body. Particular attention might be directed to the pilot oxygen low-shaft furnace installed there and fully described in "Stahl und Eisen" 74, (1954) (Der Niederschachtofen und seine Arbeitsweise). Here the first practical tests on oxygen blowing were made, which later led to the interesting developments in Austria.

One of the most interesting works of this company are at Choindez. A low-shaft electric furnace was installed there during the war as an emergency measure (operating on high-cost hydro-electric power), and with only detail modification of the original technique it is still proving an efficient iron producer. The main advantage claimed is the saving of coke, as the burden is heated by electricity and coke is used only for the reduction of the ore. Coke consumption per ton of pig iron is thus equivalent to only about 40 per cent, of the coke consumption in the average blast furnace. Moreover, the coke does not have to be of metallurgical quality; use has been made of home gasworks coke and even of low-grade anthracite from Canton Valais. These advantages are particularly important for Switzerland with her lack of coking coal.

The furnace itself is a closed low-shaft Tysland-Hole three-phase unit, with a nominal rating of 7500 kva, although normally it is operated at between 6000 and 6500 kva.

Electric power for the furnace is obtained from the Berne power station, and is brought to Choindez by means of a 45,000-volt, three-phase overhead conducting system specially constructed for the purpose. The furnace burden consists of 60 per cent iron ore, principally from the Delsberg and Mont Chemin deposits, 30 per cent pyrites sinter from the sinter plant at the works, and 10 per cent iron-bearing additions (slag, scrap and scale). Coke consumption per net ton of pig averages 800 lb, power consumption 2700 kwhr, electrode consumption 31 to 33 lb.

Output was originally rated at 55 tons per day, but it is now in the region of 80 tons per day. The average pig-iron analysis is 3.6 to 4.2 per cent C, 1.0 to 3.0 per cent Si, 0.2 to 1.0 per cent Mn, 0.2 to 0.3 per cent P, and up to 0.05 per cent S; the slag has an average analysis of 40 to 45 per cent CaO, 1/10 per cent MgO, 25 to 30 per cent SiO, and 15 to 25 per cent Al_2O_3.

Mill capacity in Switzerland is approximately 195,000 tons per annum, but as home steelmakers cannot meet this demand, capacity operation is partly dependent on imports of semis (mainly billets, which last year amounted to 60,000 tons).

BELGIUM

As an active member of the European Coal and Steel Community, Belgium is not only responsible for improved output figures to swell the community total but also contributes most notably to the general pattern of research. Work in the latter connection is referred to in a later chapter. General conditions as to raw materials supplies will affect Belgian development in a manner similar to that of neighboring countries; but new plant continues to be proposed and installed as the following list shows. The author is indebted to Prof. Coheur for this up to the minute information:

Cockerill-Ougree are installing a 1650-ton mixer and a battery of 36 coke ovens.

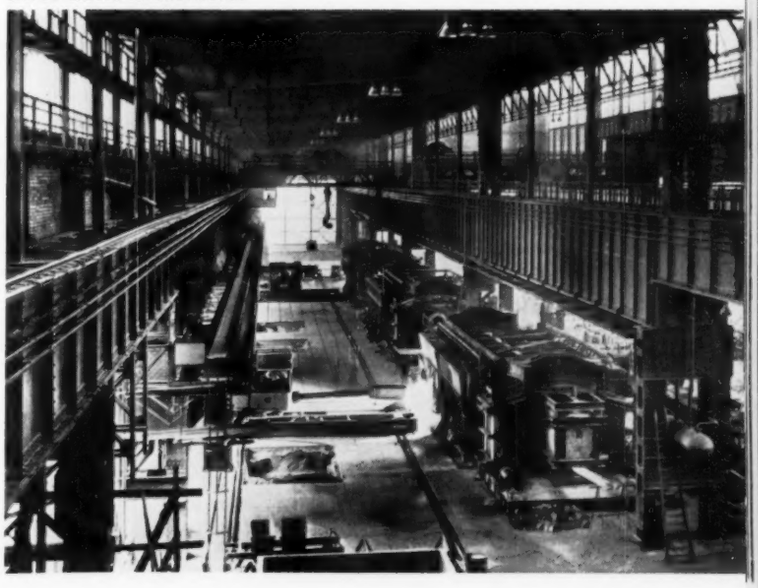
Esperence-Longdoz are having a three-stand tandem four-high cold rolling mill and a 1100 ton mixer.

Hainaut-Sambre will add a fifth 30-ton converter and a 1100-ton mixer.

Modernization of the steel plant is taking place at Thy-le-Chateau.

Forges de la Providence/Marchienne are constructing a sintering plant.

Figure 13 — At Salzgitter there are three 165-ton tilting open hearth furnaces which operate in conjunction with three basic bessemers.



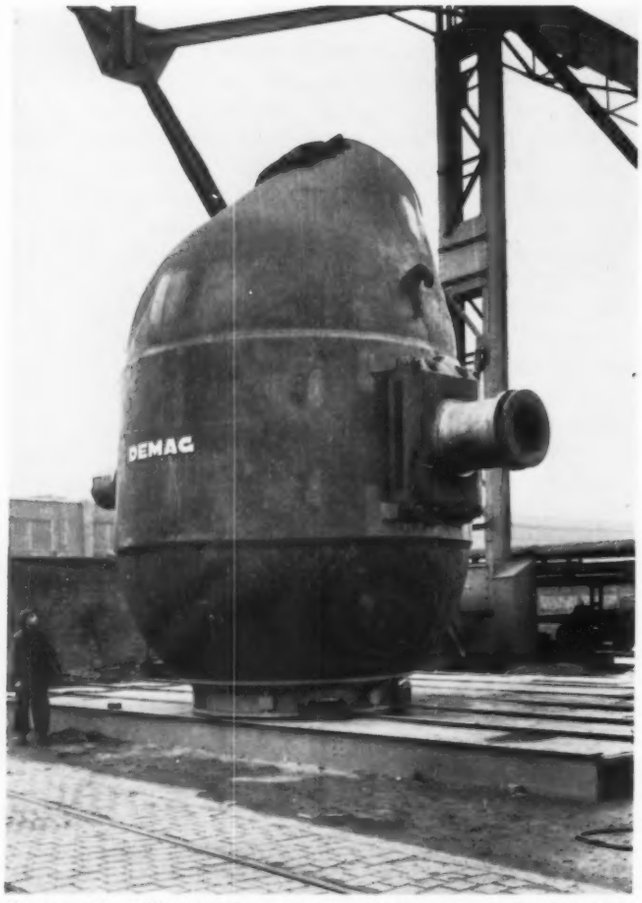


Figure 14 — Elimination of rings from converters makes possible increasing size without respacing stands.

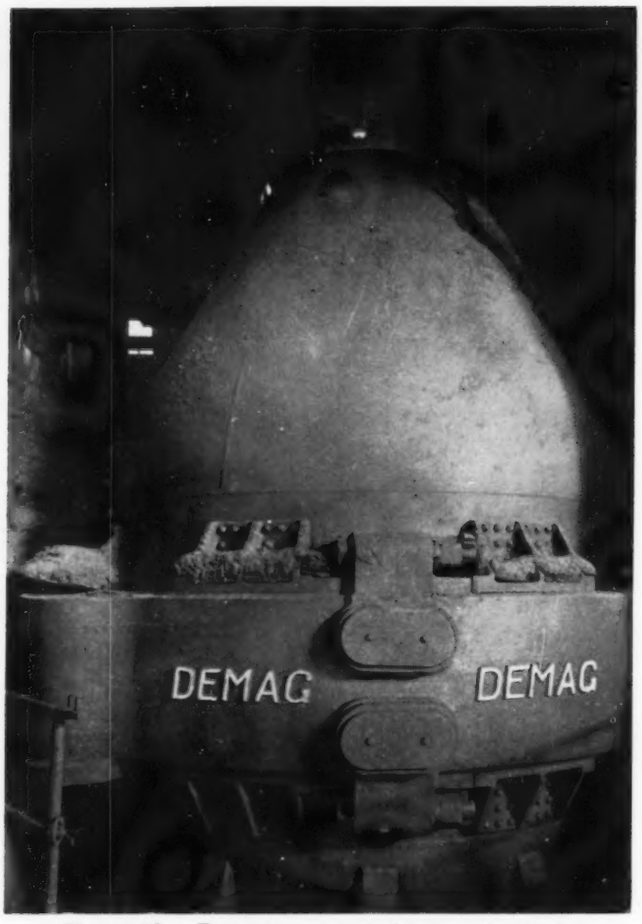


Figure 15 — European oxygen-blown converter.

Usines Gustave Boel are adding a new blast furnace. Forges de Clakecq are installing their fifth blast furnace and a 1100-ton mixer.

The latest output figures for ingot steel are 1955, 6,500,000 net tons (increase of 19.5 per cent over 1954); and 1956, 7,000,000 net tons (increase of 8.2 per cent over 1955).

ITALY

The effect of World War II on the plant available for Italian iron and steel production was devastating, war damage being heaviest in the blast furnace section of the industry. In addition, the country experienced severe post-war economic difficulties and a proposition was even made that the entire steel industry should be discontinued, leaving the country wholly dependent upon imports. This view did not prevail, however, and a long-term rehabilitation program was drawn up for inclusion in Italy's four-year ERP plan. This provided, in the first instance, that the home industry would produce 3,300,000 net tons of the estimated crude steel requirements; 1,300,000 net tons was to be produced by privately-owned plant, the balance coming from the state-controlled sector. At that particular point rationalization of production was essential, mainly to ensure drastic reduction in production costs. Production was therefore concentrated at three integrated plants on the coast, Bagnoli, Piombino, and Cornigliano. The rebuilt Bagnoli plant was designed to produce 385,000-tons of pig iron and 360,000 tons of basic bessemer steel annually, mainly concentrating on structural steel, rods and bars. The designed figures for Piombino were 228,000 tons of pig iron, and 270,000 tons of open-hearth steel, concentrating on structurals, rails and semis. Cornigliano is an entirely new plant of which more details will be given later. It was designed to produce 470,000 tons of pig iron and 550,000 net tons of open-hearth steel annually, concentrating on flat-rolled products by means of a semi-continuous 80-in. hot strip mill and continuous cold finishing mills.

These arrangements certainly effected reduced production costs, for which the following reasons may briefly be given: (1) transport advantage on Mediterranean ore; (2) increased use of natural gas; (3) low labor costs.

Coming now to the present day, an encouraging growth of Italian steel output is to be recorded. In 1956 the iron and steel industry established new records, producing about 7,200,000 net tons of crude steel and more than 2,200,000 tons of pig iron, an improvement of 9.2 and 10.5 per cent respectively over the figures of 1955. In 1956 for the first time this century Italy became an exporter of rolled steel products. As regards further expansion, the main difficulties are the shortage of coking coal and scrap, and it is to be noted that most of the coke used is made from U. S. coal imports.

Cornigliano—One of the largest post-war projects conceived by the rehabilitation plan was the building of the Cornigliano plant on the site of a previous plant which never came into production. Before the war a deep-water site had been chosen, adjacent to Genoa, for the

purpose of erecting a steel plant, but before the end of hostilities everything has been dismantled and either removed bodily or broken up for scrap. The new plant, however, which is designed to produce open-hearth steel, was planned to be three times the size of the previous one. Thanks largely to the experience of both British and American engineering firms, rapid progress was made in the construction, notwithstanding the fact that considerable building space had to be reclaimed from the sea. The story of how this extension was accomplished is outside the scope of this paper but is well worth study by plant engineers. Table V gives the designed figures for the whole plant.

TABLE V
Designed Output Figures for Plant and Equipment at Cornigliano

Department	Capacity, net tons per annum
Pig-iron production	
2 blast furnaces	600,000
Melting shop	
5 x 180 tons open-hearth furnaces	550,000*
Hot rolling	Tons per hour
Roughing mill of 1150 mm roll diam	150
Semi-continuous strip mill, comprising reversing stand with 3m table, 6 finishing stands of 2m table, with finishing equipment	120
Cold rolling	
Continuous mill comprising:	
4 stands with 1.7m table	60
1 reversing stand with 1m table, and appropriate finishing equipment, also department for tinning and galvanizing	8/10

* Plan allows for ultimate expansion to 1,100,000 tons per annum

Vado—Still in process of development, the largest Italian project yet conceived has been sponsored by the principal privately-owned steel companies. This is to provide a modern steelworks at Vado, near Savona. It is hoped to commence production here in 1959/60, and the project has already been favorably received by the European Coal & Steel Community. Briefly, it is proposed to erect two blast furnaces (producing about 1,000,000 net tons of pig iron a year); a steelworks of 770,000 net tons per annum capacity; also a blooming mill, and a continuous mill for blooms and billets with a joint capacity of about 660,000 tons per annum. This plant would therefore not only be self-supporting but also would have an available surplus for associated companies possessing no blast furnaces.

The Italian target is to have a steel output of 8,800,000 net tons per annum by 1960, so that the new blast furnaces now proposed for Bagnoli, Piombino, Cornigliano and perhaps Apuania will materially assist that aim.

The home consumption of steel in Italy has always been very low, mainly owing to the industry's high production costs. Study of the post-war situation, however, suggests that with the increasing mechanization of plant and equipment, these costs will become comparable with other countries in the European Coal & Steel Community.

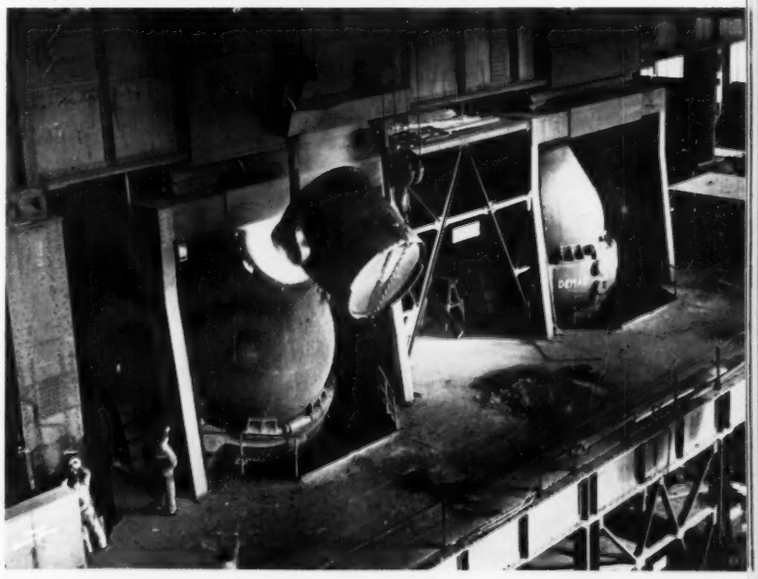
AUSTRIA

One of the major factors in Austria's economy is the ownership of very large deposits of iron ore of high

Figure 16 — View shows 60-ton basic bessemer in converter shop at Salzgitter.

Figure 17 — A large converter is being charged in Germany.

Figure 18 — Original oxygen converter steel plant was at the Oesterreichisch Alpine-Montangesellschaft at Donawitz, Austria. Units shown are 30-ton units.



purity. The ore contains almost no sulphur and no phosphorus, but is very high in manganese. An approximate analysis of the ore from the Iron Mountain in Styria shows a 30 to 32 per cent iron and a 2.5 to 3.0 per cent manganese content. This ore is the basis of the whole Austrian steel industry. It was exploited in Roman times, and since then has been smelted by the processes current at the time.

After the collapse of Germany in 1945, the Russians occupied a large part of the country, and a considerable quantity of machinery was removed. Thanks to Marshall Aid, however, very generous replacements were made, notably a complete cogging mill, a continuous billet mill, and a new heavy section mill, so that by the end of 1952 the Donawitz steelworks were able to produce rolled sections and bars at the rate of over 55,000 tons per month.

The present economic situation in Austria was recently examined by Oberregger.[15] It is a tradition of the conference to which this lecture was given that methods of production are dealt with and no emphasis is needed now on the importance of the L-D process in Austrian steel production. This process is dealt with elsewhere in this paper. The national report is one of steady increase in production; e.g. in 1956 the output of raw iron increased by 15.3 per cent, crude steel by 14 per cent, and rolled steel by 9 per cent. In total this represents 1,660,000 net tons in 1955 to 1,910,000 net tons in 1956. Whereas in 1953 only 25.9 per cent of the entire raw steel production was oxygen steel, this percentage increased in 1954 to 35.9, in 1955 to 37 and in 1956 to 40.91 per cent, the exact figure being 940,000 net tons.

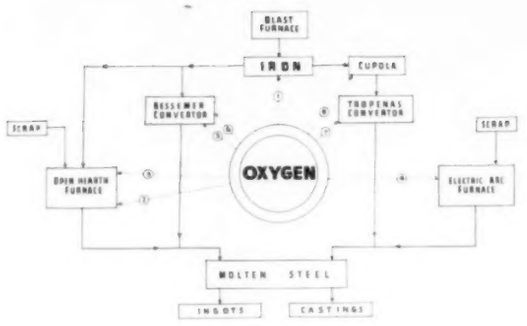
The shortage of coking coal is, in common with other countries, a major national difficulty, but attention may be directed to the developing use of hydroelectric power. The Kaprun power station[16] is able to supply the whole of Austria with peak load power especially in winter, and is geographically destined to play in the future a leading part within the central European network. The estimated annual power production of the whole project is 600,000,000 kwhr.

Not unnaturally, therefore, the focal point of interest in Austria is the L-D process, and further development will be of great interest. Other plant installations are to be noted, however, e.g. the three-stand two-high reversing mills installed by Gebruder Bohler in Kapfenberg. The roll diameter is 27.5 in., the screwdown being electrically operated. The 34-in., two-high reversing blooming mill for rolling down blooms of up to 2.5 tons at these works can also be adapted for smaller sizes; this is one of three that have been supplied from Germany.

This is a country of great technical interest, and well repays study.

NORWAY

Norway is a country of great natural resources which have attracted to it much raw material from other parts of the world. For example, the seemingly limitless hydro-electric power available and potential is being increasingly used. This is mainly responsible for the growth of manufacture by electrical processes, which has been stimulated by such discoveries as that of Pedersen in respect of smelting, and of Birkeland in the process of oxidation of nitrogen. Amongst the many technical processes pioneered in Norway is that of



ITEM	APPLICATION	EFFECT OF OXYGEN	POSSIBLE INCREASE IN STEEL OUTPUT
1. Blast Furnace Iron	Pretreatment in ladle or mixer	Faster removal of silicon	15%
2. Open Hearth Furnace	Assisted melting by flame enrichment	Faster melting of scrap	15-20%
3. Open Hearth Furnace	Assisted refining	Faster removal of carbon	12-15%
4. Electric Arc Furnace	Assisted refining	Faster removal of carbon	10%
5. Bessemer Convertor	9% Oxygen enrichment of air blast	Shorter blowing time	15%
6. Bessemer Convertor	Oxygen/steam blast	Shorter blowing time and production of high quality low nitrogen steel	20%
7. Tropenas Convertor	9% Oxygen enrichment of air blast	Shorter blowing time	20%
8. Cupola	2% Oxygen enrichment of air blast	Faster rate of melting pig iron	20%

Figure 19 — Schematic diagram illustrates use of oxygen in European steelmaking plants.

smelting of pig-iron in a low-shaft electric furnace (Tysland-Hole). The first installation of this plant was at the works of Christiania Spigerverk over 30 years ago, but since then the design has become well known throughout the world.

The most notable development in Norway in recent years has been the erection of a new iron and steelworks at Mo i Rana by A/S Norsk Jernverk. The considerable history of Norwegian technology behind this plant has made the result one of great interest throughout the world, and it should be noted that both the general layout of the ironworks site and the rich sources of electric power will permit extension at a later date. The first construction stage, based on three pig iron furnaces, was designed to produce about 190,000 tons of rolled steel products. The second stage, of six pig iron furnaces, involves capacity of about 370,000 tons, while the third and final building stage of eight pig iron furnaces is concerned with a capacity of about 550,000 net tons of rolled products annually. The full description of the plant is well worth reading[17]; it will suffice for present purposes to draw attention to the three electric pig iron furnaces (with possible developments), the power supply, and the raw materials available. The electric furnaces are all of the Tysland-Hole type. The self-baking electrodes, 59 in. diam, are dimensioned to give a power density of about 90,000 amp per electrode, and

TABLE VI
Norway—Production, Net Tons

	Iron and titanium ore	Pig iron	Ferrosilicon 45 per cent basis	Steel
1955	1,560,000	136,000	119,000	188,000
1956	1,880,000	204,000	119,000	316,000
Jan./Apr. 1957	646,000	84,000	45,000	129,000

based on this each is rated as being 20,000 kw. This is believed to be the highest load ever applied for electric pig iron smelting.

The power supply is transmitted from Rossaga power station and distributed as under:

	Kw
Sintering plant	2,500
Pig iron furnaces	60,000
Electric arc furnaces	16,000
Bessemer converters	3,000
Rolling mills	8,000
Electric soaking pits	1,500
Auxiliary motors, lighting etc.	5,000
	96,000

The abundant supply of ore in the Rana district was one of the main reasons for choosing this site. The sydvaranger ore concentrate, known to many British importers, is produced from a siliceous rock containing 32 per cent Fe as magnetite. Norsk Jernverk absorbs approximately 150,000 tons of the output. The Fosdalen ore concentrate is also supplied to Norsk Jernverk, with a general analysis of 66 per cent Fe, 0.23 per cent Mn, 0.025 per cent P, and 0.6 per cent S. It sinters readily in the type of plant in use.

Norway has no coal deposits within her own borders and the works therefore depend on imported coke and breeze. Extensive studies are now proceeding on the coalfields at Spitzbergen to compensate for present shortages.

Elsewhere in Norway the reports are all of increased production and brisk development. The current production figures tell their own story:

Total ingot output expected at Norsk Jernverk in 1957 is 250,000 net tons, but a new electric pig iron furnace is now under construction and will be put into operation about the middle of next year. This is expected to increase the yearly ingot output to about 300,000 to 310,000 net tons. The yearly ingot output of Christiania Spigerverk is 115,000 tons.

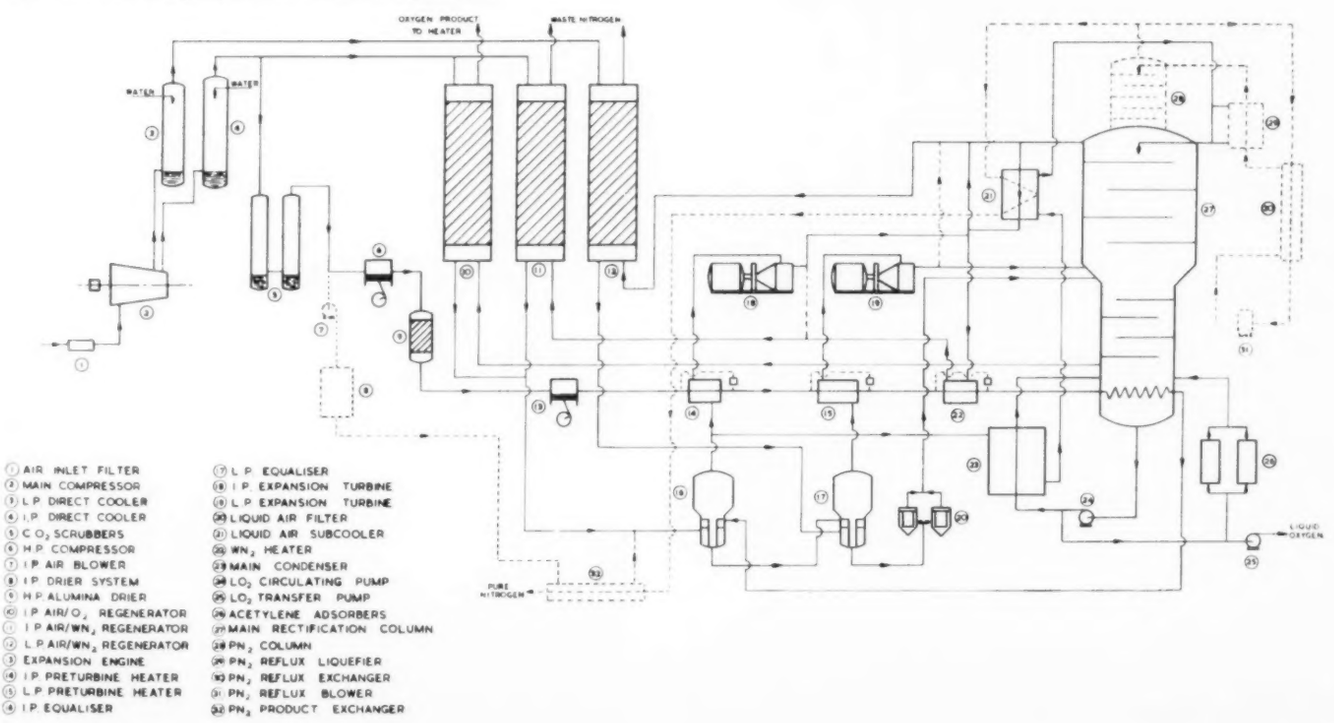
SWEDEN

The present trends in Swedish steelmaking are of comparatively recent origin, notwithstanding a rich historical background. Fundamentally, the difficulty in all development work has been fuel, although this may seem peculiar in a country so richly endowed with natural resources of water-power. The steady expansion of hydro-electric power has been important but insufficient. Continued improvements in design and construction methods for dams and plants have increased the power available, so that today about 23,000,000,000 kwhr are being produced, while a total of 35,000,000,000 kwhr is planned for the early 1960's. When the present theoretical maximum output is achieved at that time, further expansion will be difficult owing to the low heads of water in the remaining waterfalls. An existing difficulty in Sweden is the fact that the main waterfalls are all far from the centers of consumption—thus entailing long and expensive transmission lines.

Ore resources—Sweden possesses very rich deposits of iron ore, the two principal mines being at Kiruna and (about 60 miles SSE) Malmberget.

There are two "iron mountains" at Kiruna, Kiirunavaara and Luossavaara, the former containing the largest body of high-grade ore in the world. The Kiirunavaara ore body is an immense inclined slab of iron ore between two beds of porphyry, quartzite on the hanging side and syenitic in the footwall, 12,000 ft long by 100 to 600 (average 300) ft wide. The ore in the Malmberget mine is similar to that of Kiirunavaara and mining here is now being reorganized to raise the production capacity to 5,000,000 tons per annum. The same mining equipment is used as at Kiruna.

Figure 20 — Schematic flow diagram shows plant recently installed at the Margam works of the Steel Company of Wales Ltd. for the oxygen/steam converter process.



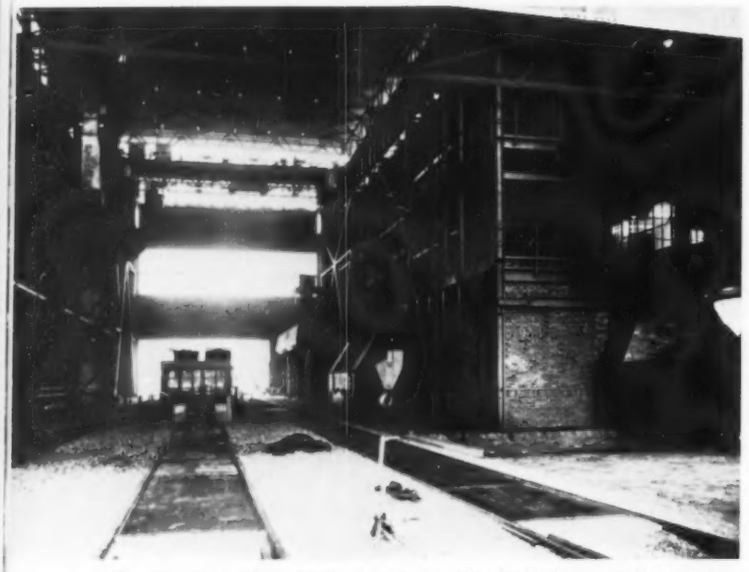


Figure 21 — Oxygen is blown in the ladle for desiliconizing at this IJmuiden, Holland plant.

The Swedish steel industry is characterized by an unusual variety of methods, the processes adopted having been dictated by local conditions. In all development work, the industry has been guided and directed by Jernkontoret, whose influence goes back to the earliest days. Sweden has made many important contributions to the study of the structure, properties, and treatment of steel, notably by such well known workers as Brinell and Benedicks. The work of Goransson, who later founded the Sandviken steelworks, is also notable for many reasons, one being that in 1857 he acquired patent rights for Sweden and Norway from Bessemer. The entirely successful blow which was made in July 1858 came at a time when Bessemer had great difficulties with his experiments in Great Britain.

Sweden has been a pioneer in the use of sinter in the blast furnace burden, and for many years it has been common practice to use burdens consisting mainly or entirely of sinter. The very effective recuperators designed by T. Lindblom are the latest steps to lower fuel consumption. Measures to overcome the disadvantage of having to use imported fuel have had to be taken, a leading example being that of Domnarfvet. By means of a sinter charge with a high degree of oxidation, and a blast temperature in the ring main of 1650 F, an average coke consumption of 1220 lb per ton of pig-iron has been obtained.

Sponge iron production is of interest in many countries, but the practical solutions of difficulties involved in its production are Swedish work. The Hoganas method, by which rich concentrate is reduced in ceramic muffles, has been in use since 1911 and quite recently a new plant, using this principal and having considerable capacity, has been started. The Wiberg method has also been developed over a considerable number of years, but it was not until 1943 that the furnace ran continuously for a considerable time. In the last five years several new furnaces have been built and successfully operated.

The pure raw materials available in Sweden have encouraged the use of the acid open-hearth process for certain qualities of steel, and this tendency is still expanding. For ordinary steel, the basic open-hearth and the electric processes are, however, paramount. In 1956, 45 per cent of all Swedish steel production was by electric furnaces.

In common with all other countries, Sweden has taken every advantage of oxygen, and one very notable development must be chronicled. The Kaldo process[18] has already been extensively described in the literature by the inventor, Bo Kalling, so that it will suffice to say here that a rotary furnace, into which pure oxygen is blown, is used instead of a converter. The properties of the steel produced are claimed to be as good as any open-hearth or electric furnace steel of a corresponding type. Fuller details of this process are well worth study.

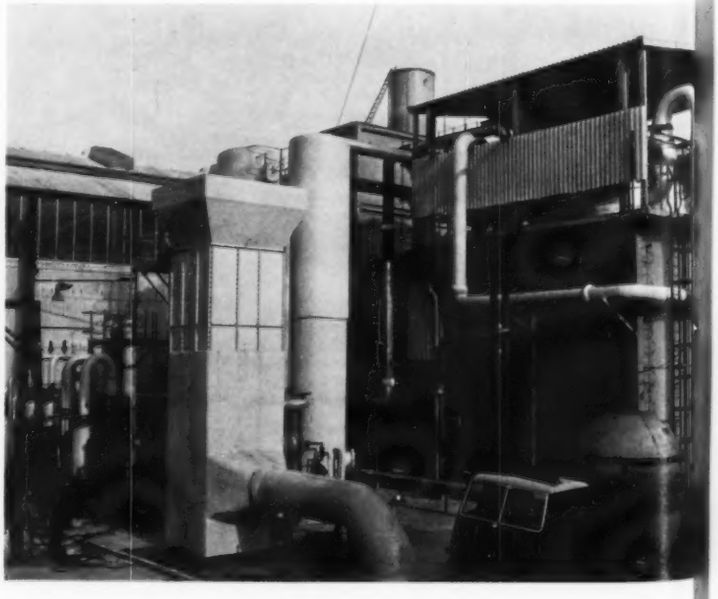
All these factors have a considerable bearing on the latest output figures for Swedish steel. Since the war the ingot steel production has doubled, from about 1,300,000 net metric tons in 1946 to 2,600,000 net tons in 1956.

While much of the plant in use in the various works has been imported, it should also be recorded that the Norlindh design mills, built by Morgardshammar, have been exported to several countries abroad.

LUXEMBOURG

No mention of this country in connection with the iron and steel industry would be complete without recording that it was here, in Dudelange, that the first charge of bessemer steel was blown on March 18, 1866. In common with all other countries, production is on the upgrade, the output of crude steel being 3,560,000 tons in 1955 (14.1 per cent increase over 1954) and 3,800,000 tons in 1956 (7.1 per cent increase over 1955). This output is given by the seven principal works, Belval, Esch, Terres Rouge, Dudelange, and Dommeldange (all ARBED), and Differdange and Rodange. A very interesting development is that of the new sheet mill section at Dudelange, which comprises slabbing mill, universal mill and all ancillary plant. This will be a notable acquisition to the industrial resources of the country.

Figure 22 — First tonnage oxygen plant installed in Great Britain is at the Margam works of the Steel Company of Wales Ltd.



GERMANY

So brisk have been developments in the German iron and steel industry (particularly since 1948) both in plant installation and in research, that it has been difficult to keep up to date with them. The demand for steel in all its forms was no doubt accelerated by the pressing need for general rebuilding all over the country, but the eager way in which these demands have been met constitute not the least interesting story of iron and steel development in Europe. The output story is told in Table VII (SOHL, Financial Times Review, May 1957).

TABLE VII
West German Iron & Steel Output

	Thousands of net tons		
	Pig iron	Crude steel	Rolled steel*
1949	7,850	10,200	7,000
1950	10,430	13,300	9,000
1951	11,800	14,900	10,300
1952	14,200	17,400	11,800
1953	12,800	17,000	11,200
1954	13,800	19,200	12,600
1955	18,200	23,500	15,600
1956	19,400	25,500	17,200

* Excluding material for final rolling.

An additional factor is the growth of German exports, particularly of such engineering products as machinery and motor vehicles, all of which helped to shape the pattern of production. This latter has been influenced by the necessity for having a balanced relationship between the outputs of blast furnaces, steelworks, and rolling mills, which, although a common problem throughout the world, was especially difficult for Germany because of: (1) widespread damage in the heavy industries, and (2) restrictions and controls which were not eased until the 1952 period.

New plant installations of the current period include 15 new blast furnaces, a number of open hearth and electric furnaces, one continuous wide strip mill, and some cold rolling plants, and several trains for light sections.

The steel industry is, to a certain extent, dependent on oil supplies, some 16 per cent of requirements being met by this means (mostly tar oil extracted in Germany).

Since Germany is a member country of the European Coal and Steel Community, development of her steel and coal industries will be integral with progress in other countries. Thus Ruhr coal is a major European raw material. Scrap supplies, too, are important, not because home supplies fall short of demand[19] but because under the common market agreements large quantities of scrap have to be exported to other members of the community particularly Italy.

The picture of German revival in the steel industry would not be complete without a word on research. The slowness with which work has been pursued in the post-war period is almost wholly for financial reasons. It is clearly recognized, however, that for increased productivity, more funds must be provided for and recognition given to research—particularly in the case of universities and such bodies at Max-Planck-Institut.

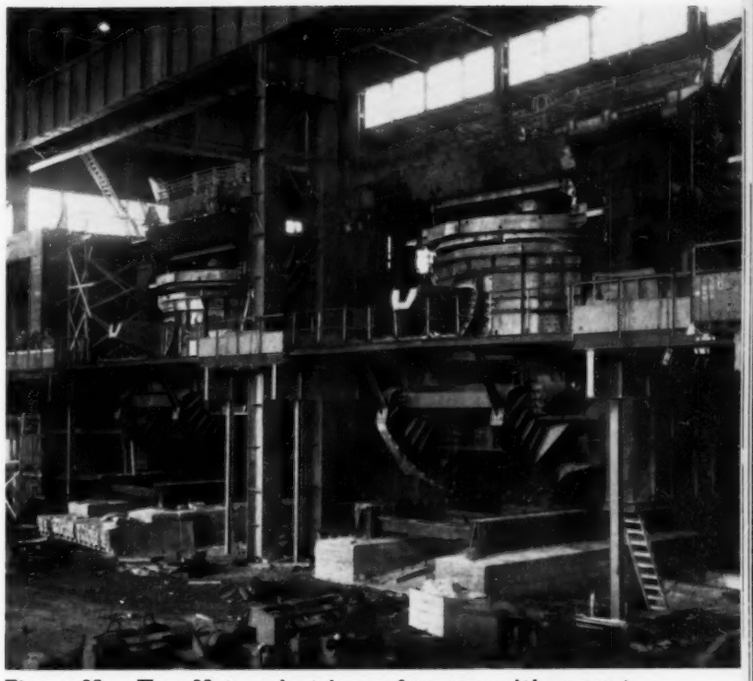


Figure 23 — Two 60-ton electric arc furnaces with runout and rotating hearth are installed at the Mo-i-Rana works of A/S Norsk Jernverk.

The position at the moment is that the Federal Government takes the view that, basically, industry and not the State would be responsible for research development.

As an example of how steel firms' investigators are diligently working, the following examples may be given. They are all contributions made to the ECAFE

Figure 24 — One of the largest electric arc furnaces in Europe, at Samuel Fox & Co. Ltd., is rated at 70 tons, has a hearth diameter of 19 ft and is operated by a 15,000-kva transformer.

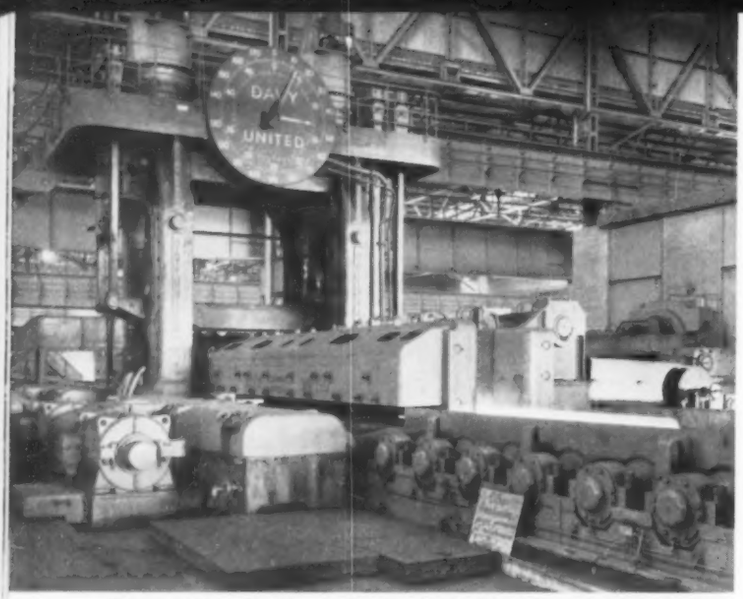


Figure 25 — A 42- x 108-in. high lift blooming and slabbing mill at the A/S Norsk Jernverk at Mo-i-Rana has a capacity of 650,000 tons a year.

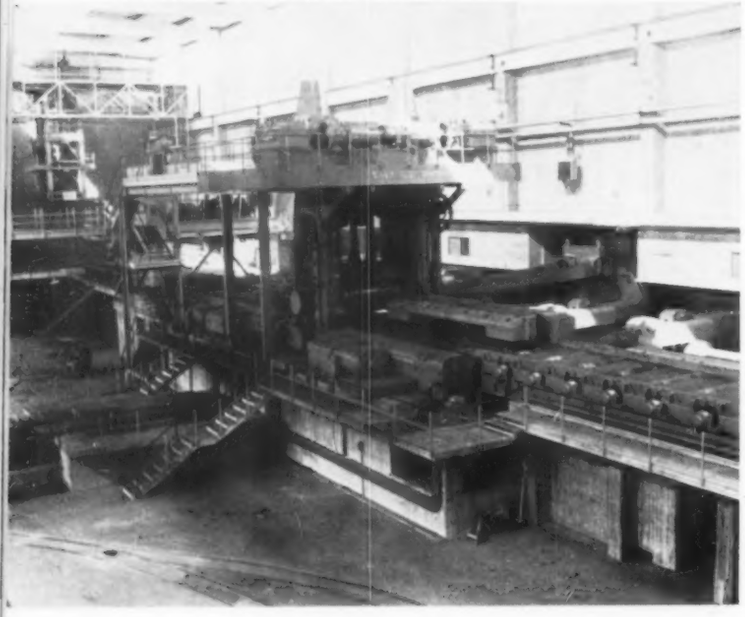
conference held in Bangkok in the middle of this year: "Low Temperature Carbonization Smelting in the Low Shaft Furnace"; "Processes for the Smelting of Iron Ores without Coking Coal"; "Influence of Pre-Treatment of Fine Ores on the Sinter Output"; "Principles and Methods of the Utilization of Low Grade or Difficult Ores"; "Continuous Casting of Steel for Small and Medium Dimensions and its Economic Prospects in Germany."

Complete examinations of the present position of the German iron and steel industry have been made.[20, 21]

THE EUROPEAN COAL AND STEEL COMMUNITY

So profound is the influence of the European Coal and Steel Community in the iron and steel production (present and potential) of countries in the area covered by it, that this paper would not be complete without an examination of its structure and possibilities. Of immediate and particular importance to countries both inside and outside the community are the common market (European Economic Community), Euratom (European Atomic Energy Commission), the European Free Trade Area, and the proposed United States of Europe.

Figure 26 — This 42-in., high-lift, blooming and slabbing mill rolls high carbon and specialty steel at the Sandvikens Jernverks A.B., Sandviken, Sweden.



Very briefly, the six member countries of the European Coal and Steel Community: Luxembourg, Belgium, France, Italy, West Germany and the Netherlands, signed the appropriate documents to form the Community in 1951. The European Common Market in its larger form came into being in March, 1957. Various discussions on the proposed Free Trade Area (with Great Britain participating) have been going on since July, 1956, but as yet no firm conclusions have been announced. The European Atomic Energy Community received official approval in Rome in March 1957.

The European Coal and Steel Community, including the Saar, covers an area of 449,000 sq miles, in which live 162,000,000 people—roughly as many as there are in the United States. The active working population of 76,000,000 is greater than that of the United States. The community produced in 1955 a record of 58,000,000 net tons of steel and a post-war peak of 270,000,000 tons of coal. It shares with Russia the world's second place in output of these products. The community's 145 coal undertakings control 459 pits; its 355 steel companies operate 455 iron and steel works; iron-ore mines number 188.

The community exercises sovereign powers over the coal and steel resources of Belgium, France, Germany, Italy, Luxembourg and the Netherlands. In addition, several foreign delegations are accredited to the High Authority, the British delegation (headed by Sir William Meiklereid) adhering, along with the United States and Sweden in 1952, Norway, Switzerland, Denmark and Austria in 1953, and Japan in 1954. The status of the United States was raised to that of a mission when Ambassador W. Walton Butterworth arrived in Luxembourg as Head of Mission in March, 1956.

None of the member countries of the community is self-sufficient. Germany produces only half the iron ore her blast furnaces need. France buys a third of her coal and half her coke from the Ruhr in particular. Belgium and Luxembourg export more than two-thirds of their steel production on world markets but depend for iron ore supplies on Lorraine and for coke on the Ruhr. Italy mines little coal; the Netherlands have not enough steel for their requirements. For full economic development, each exchanges resources.

In action, the High Authority is charged with establishing and maintaining the common market by levelling frontier barriers, and doing away with all trade restrictions for coal and steel among member nations. This policy necessarily entails direct interest in every aspect of these basic industries, e.g. research, financing of investments, the reorganization and modernization of enterprises in competition on the common market, and partial financing of technical training. To finance all its activities a levy is imposed of not more than 1 per cent on the value of the community's coal and steel production. In addition to this levy, extra funds have

TABLE VIII
Borrowings of the High Authority

Country	Lender	Date	Dollar, units of account
United States	U. S. Government	1954	100,000,000
Belgium	Caisse Generale d'Epargne et de Retraite	1955	4,000,000
Germany (Federal republic)	Rheinische girozentrale und Provinzialbank	1955	5,952,381
Luxembourg	Caisse d'Epargne de l'-Etat	1955	500,000
Saar	Landesbank und Girozentrale Saar	1956	1,000,000
Switzerland	Public issue	1956	11,655,012
Total			129,059,774

been necessary, and the borrowings are listed in Table VIII.

From the borrowed funds, loans have been granted as follows:

a. Modernization of coal mining installations including coking plants	$ 35,140,000
b. Pit-head power stations for the consumption of low-grade coal	46,310,000
c. Expansion of facilities for the production and dressing of iron ore	18,550,000
d. Modernization of facilities for the production of pig-iron	11,660,000
e. Housing for miners	17,400,000
Total	$129,060,000

From the beginning of its activities, the High Authority was worried by the relatively poor effort devoted to research in the community, as this compared unfavorably with that of the United States, U.S.S.R. and Great Britain. It has now been quite clearly laid down, however, that research is an essential part of, and complementary to, the long-term planning policy. The expansion of industry is recognized as being governed in very large measure by progress in scientific knowledge and technical "know-how," also the speed with which the results are put into practice on as large a scale as possible.

Figure 27 — Reversing two-high blooming and slabbing mill at Dalzell works of Colvilles Ltd. has 44-in. diameter x 10-ft long rolls.

Naturally a major portion of the research effort is directed towards making the utmost use of the available raw materials of production. So much has to be imported, coal, ore, and scrap, that every advance in their efficient use is of importance. Indeed, so vital are these imports that the development of plants along the seaboard is even now taking place—far from the coal and ore fields, where conventional progress has been made.

It is no easy matter to co-ordinate the research activities of such a wide area, and it has been no part of the policy of the High Authority to overlap the work in progress at producers' works and research centers. The aim has really been to make it possible to embark on programs which are too ambitious for the funds directly available and which are rendered more effective by co-ordination.

Brief details may now be given of the research work in progress, but the full subject of research and development is discussed elsewhere in this paper. Comparative tests are being made with different grades of coke at the Dillingen steelworks in the Saar. The technical conditions (particularly the formation of scale) obtaining in steel rolling are being made the subject of a comprehensive study, in which two steelworks, twelve rolling mills, fifteen works' laboratories, and two research centers are participating. Publication of reports on this work is imminent. Study of silica bricks in open hearth furnaces is taking place at sixteen steelworks in four member countries. The well known work on flame radiation at IJmuiden has already been referred to in this paper.

Work now proceeding in a low-shaft furnace (operating as a model blast furnace) in Liege, has an important background. Considerable difficulty is being experienced in meeting the coke requirements of the iron and steel industry, so that this research has been financed with that specific end in view. This project is also discussed elsewhere in the paper, but it should be added that special notice has been taken by the High Authority of the possibility of using sources of energy other than coke for the non-chemical side of its action in the blast furnace.

Since the newer steelmaking processes have also been mentioned elsewhere, work on them need not be reiterated, other than to say that they offer peculiar and special attractions to an area that is carefully concerned with its investment policy. To show how the pattern of ingot steel production is shaping by processes at this moment, reference may be made to Table IX, but it must be remembered that there has not been time yet for the newer processes to make very effective contributions, nor have the figures from Austria been included. Area development is shown in Table X.

THE COMMON MARKET

The evolution of the common market for steel during the year 1956 and the first half of 1957 has been marked by a continuous increase of both demand and production. In general, deliveries were inadequate for certain classes of rolled products, but demand was par-

TABLE IX

Crude Steel Production by Manufacturing Processes
(Thousands of Net Tons)

	Basic bessemer	Acid bessemer	Open-hearth	Electric furnace	Others	Total
1953	23,000	220	16,900	3,370	53	43,600
1954	24,900	210	19,200	3,900	5	48,000
1955	30,200	270	22,500	4,800	13	58,000
1956	32,300	280	24,300	5,600	19	62,500
1st quarter*	2,950	23	2,000	420	1	5,100
2nd quarter*	2,690	24	1,970	460	1	5,150
3rd quarter*	2,650	22	2,040	450	2	5,150
4th quarter*	2,490	24	2,100	505	2	5,400

* Monthly average.

ticularly active for heavy and medium-gage sheets and sections. Iron and steel production during the whole of that period was limited by the available supply of raw materials, shortages being particularly felt in the supplies of coke and scrap.

The common market, as such, fully operates only among member countries, but the method of operating it has wide terms of reference. Briefly, the three tasks of the community's institutions (more directly the High Authority) are to remove impediments to trade, apply rules of competition, and promote economic and social progress. These purposes obviously entail direct interest in a much wider field than coal and steel production, agriculture and transport being examples of development which come immediately to mind.

The European Free Trade Area is not to be confused with the common market. It has been felt in Great Britain that export markets must be safeguarded and other obligations honored, so that a wider form of cooperation, known as the European Free Trade Area has been brought into being. In effect, this means that the six common market countries would share in the free trade area but would still form their common tariff against countries outside it. The United Kingdom has made proposals that the free trade area should consist of all those O.E.E.C. countries who may wish to join, and that it should not be concerned with agricultural products, drink, or tobacco. This arrangement would allow the United Kingdom to export industrial goods duty-free to the common market countries as well as those in the free trade area, in return for duty-free entry of such goods from both areas into the United Kingdom.

Briefly, the advantages suggested for British participation in the free trade area are: (1) increased export to Europe, particularly in such growing industries as electronics, chemicals and engineering; (2) competition with Europe would stimulate investment in plant and machinery in British industry; (3) the broadening of Britain's home market would greatly increase the British competitive position in exporting to the outside world.

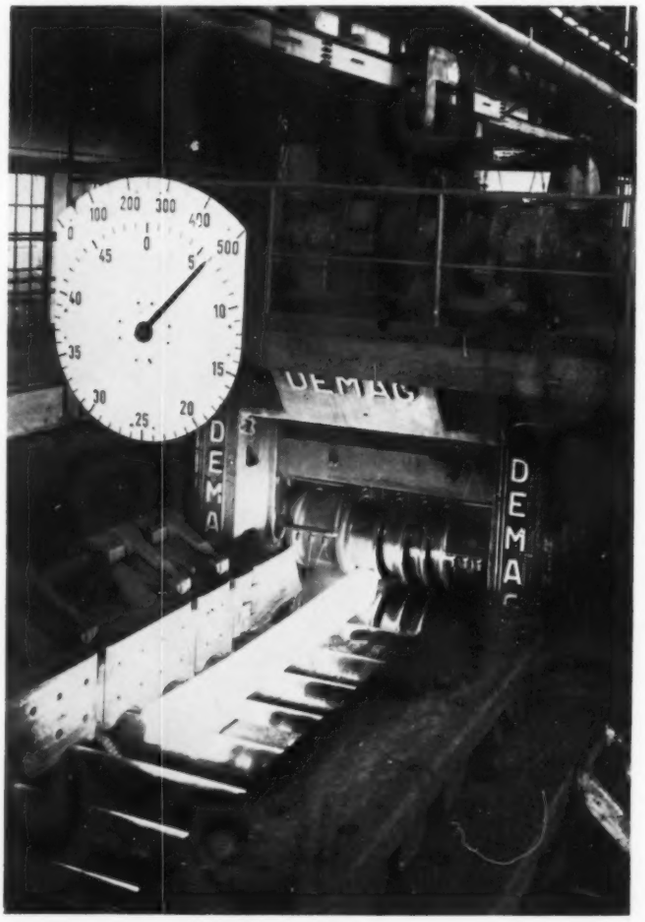
Inevitably, then, these activities, coupled with that of the newly-created European Atomic Energy Community, are leading to the creation of a "United States of Europe." Already there is an action committee charged with this purpose, but it is too early yet to acquire details of its structure or control.

TABLE X

Crude Steel Production by Areas
(Thousands of Net Tons)

	1952	1953	1954	1955	1956
North Rhine Westphalia	14,800	14,300	16,100	19,400	21,000
Lorraine	7,820	7,330	7,850	9,200	9,700
Northern France	2,560	2,320	2,500	3,080	3,260
Lower Saxony and Schleswig-Holstein	1,410	1,540	1,770	2,570	2,960
Bavaria	590	545	600	710	745
Central France	780	590	590	700	780
Rhineland-Palatinate	500	470	560	634	640
Western France	520	550	525	595	660
Southeastern France	160	148	160	198	215
Hesse	82	76	92	125	140
Southwestern France	84	65	77	105	110
Baden-Wurttemberg	33	29	32	34	38

Figure 28 — Unit shown is a 34-in., two-high reversing blooming mill at Gebruder Bohler, Kapfenberg, Austria.



RESEARCH AND DEVELOPMENT

While research and development work is carried on unremittingly in all iron and steel producing countries, alterations or modifications in processes are made but slowly, for a variety of reasons. The most obvious one is the size and costliness of the plant in general use. Small scale experiments seldom give comparable results in full scale operation, as it is difficult—if not impossible—to simulate works conditions in heavily scaled-down plant. Scale models are, of course, in use, e.g. the study made by IRSID of the movements of the bath inside a converter during blowing. In this case a one-tenth scale model in which water takes the place of liquid pig-iron has been used for examination of the happenings on an industrial scale. A much larger scale is used (one-third) for the furnace at IJmuiden being used for flame research, the same scale being used for the low-shaft furnace at Ougree (which is at the same time a small experimental blast furnace), and a coking research station at Marienau which has four normal-size chambers. The work at all these stations is, however, very expensive. Again, all steelworks plant is at present fully occupied with production to satisfy existing demand and preference is usually given in expansion schemes for the provision of plant to augment output figures rather than for experimental equipment.

For these and other reasons, full plant trials are seldom possible, desirable as they are in cases of extreme importance. The time may yet arrive when such full-scale trials will be essential, and the thoughtful student of the potential rapid advance of steelmaking technology in Europe might suggest that that time is now here.

Nevertheless, many importance advances in steel technology must be recorded here under whatever heading they are classed. The difficulty is to make a selection from the vast amount of work that is under way both in individual works organizations and in central research establishments throughout the European area. What is important to a worker in the sintering process tends to have only academic interest to one engaged on research such as the plastic coating of steel strip, but an attempt will be made to portray a cross section of the work under way—with advance apologies for any omissions! Even the bessemer process itself was discredited in its early stages, so that there may well be some work on which report has been made but of which sufficient notice has not been taken in this paper.

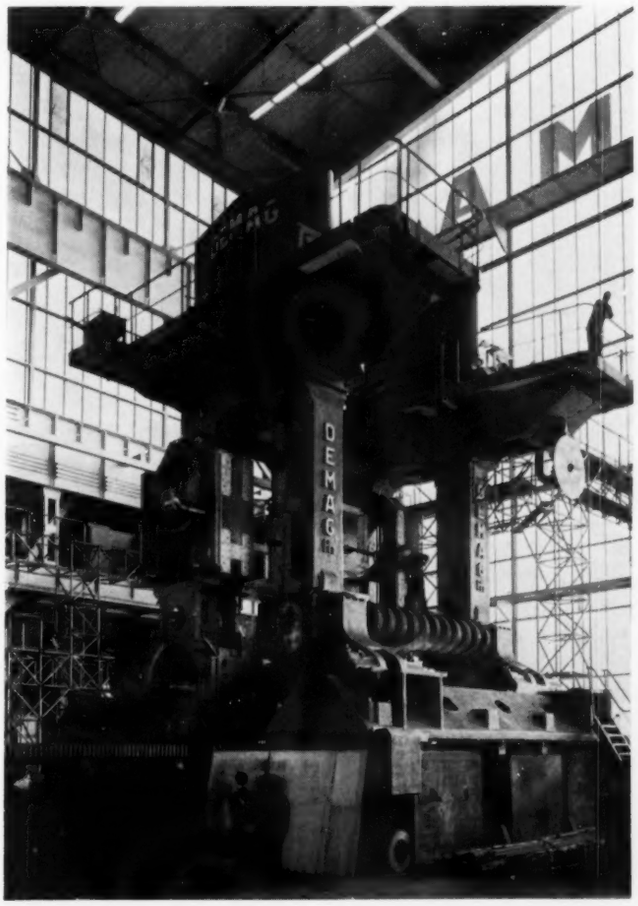
RAW MATERIALS

In view of the rapid increase in the demand for pig iron and the heavy load on the coal industry and in particular the increasing difficulty in securing coking coal of the desired quality, special attention has been given to research on the raw materials used in the blast furnace. The High Authority of the European Coal & Steel Community are providing funds for comparative industrial tests to be made with different grades of coke in blast furnaces at the Dillinger Huttenwerke in the Saar, with hard Ruhr coke and softer grades of coal less suited for coking than the Ruhr coal. The tests are being carried out in two identical blast furnaces and under identical operating conditions. Difficulties over coke supplies have hitherto made it impossible to be sure of the regular supply of Ruhr coke which will be necessary throughout the tests. Arrangements have therefore been made for the tests to begin after the end of the cold weather which could affect the progress of the research.

Determined efforts are also being made by the High Authority to achieve a really substantial reduction of the coke input ratio at the blast furnaces. Funds have therefore been provided for tests in Liege in a low-shaft furnace operated as a small blast furnace. In this way each test can be carried out in less time and at less cost than it would take in an ordinary blast furnace. The Liege plant is particularly well equipped and staffed both for the preparation of the burden and for all ancillary work. The program of tests will extend over three yars and has been worked out with the object of making a systematic study of the different factors affecting the coke input ratio.

The Low-shaft Furnace—Since the work at Liege on the low-shaft furnace is so important, fuller details of it may be given. The first year of operations was completed in 1954; this was divided into three phases: (1) runnings-in period, when the staff could really get acquainted with the plant; (2) determination of satisfactory methods of operation, a poor grade of Luxembourg ore was used and later a calcareous Piennes ore, and the fuel was a poorish grade of small metallurgical coke, fairly variable in size according to its origin; and (3) the third series of trials was mainly based on the

Figure 29 — Plate mill shown is one of the largest in Europe. It is located at Henrichshutte Hattingen.



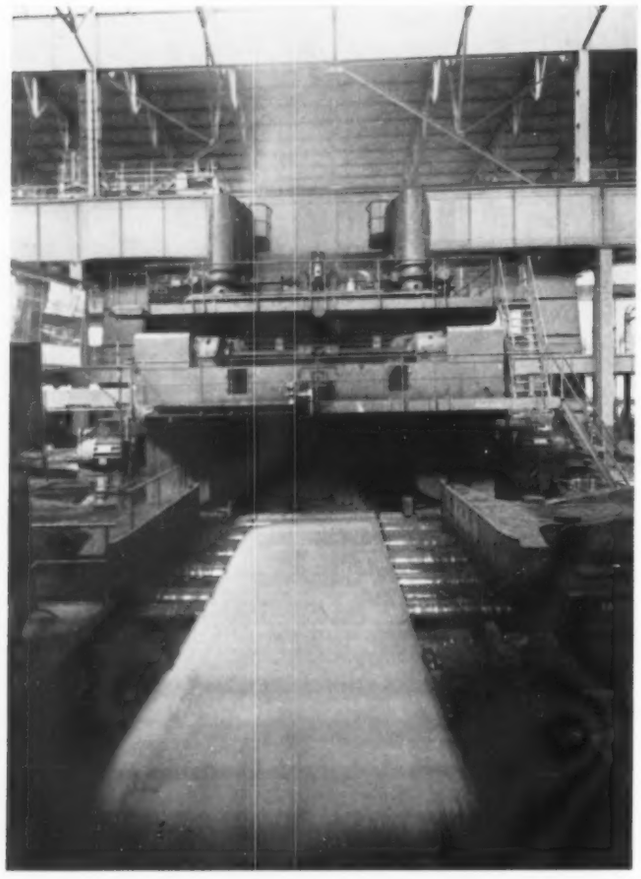


Figure 30 — This Henrichshutte Hattingen plate mill has what is believed to be the largest roll neck plain bearings. It was put in operation in 1956.

exclusive use of semi-coke from Bruay and calcareous Ida ore.

During all these tests the blast was in general enriched with 28 per cent oxygen, but atmospheric air was also used on occasion. Despite initial difficulties, many important results were obtained. The whole project has been very fully examined[22, 23] so that only the main points will be given here.

The furnace can produce cold bessemer pig iron starting from raw materials which could not have been used in the blast furnace owing to their size or composition. It can deal with bulk charges of poor ores (30 per cent Fe) of small size. Results are better when the size of the coke used is comparable with that of the ore in the burden, rather than when larger coke is used. However, with decreasing size of raw materials, the amount of dust thrown out increases and the dropping of the burden becomes irregular. It would appear that any idea of using a large amount of materials smaller than 500 microns without preliminary sintering must be abandoned. The use of semi-coke, obtained from non-coking coal, has given excellent results, thus opening the way to the use of inferior fuels. Some tests using 25 per cent anthracite or coal have also given encouraging results. The use of air-enriched with oxygen does not seem indispensable. Finally, segregation of materials, due in large part to a poor arrangement of the charging machines, has been essential owing to the low inertia of the plant.

The future program may be briefly outlined. It has been found necessary to modify the throat and charging system for the next stage. The same materials will be used as before and the first objective is to obtain more stable working of the furnace. The use of counter pressure is envisaged. Research on the least expensive method of sintering is proceeding, as at a later stage sintered material may be used.

So widespread is the interest in this work that seven countries (Austria, France, Belgium, Greece, Italy, Luxembourg and Holland) set up the original investigating body, with USA later adhering and Great Britain an associate member. Germany is represented on the technical committee, consulting members being Sweden, Switzerland and Jugoslavia. The research is under the C.N.R.M., Liege, under the direction of Prof. Coheur, and is financed by IRSIA. The general committee (president, M. Malcor) decides the general research programme; the technical committee (president, M. Allard) deals with details of—and adjustments to—the plant, decides the tests to be made and discusses the results; the executive committee (president. M. Wurth) is composed of a number of Belgian and Luxembourg specialists who generally supervise the work. Further reports of this research will be awaited with great interest.

Consideration is also being given in Britain to the possibility of a limit to the reduction in coke consumption. Results already achieved show that with an all-sinter burden made from relatively lean home ores, the consumption is under 1700 lb per ton, while with rich imported ores under the same conditions 1300 lb of coke per net ton of iron is possible. Ultimately the national average consumption is expected to be between 1500 and 1000 lb per ton for basic iron furnaces, provided adequate ore preparation and sintering machinery are installed and the quality of the available ores does not greatly vary.

Figure 31 — Control pulpit for 11-in. continuous bar mill at the Park Gate Iron & Steel Co. Ltd.

From the continent, however, work has been reported on the production of metallurgical coke from coal hitherto considered uncokable. The Lorraine coals, for example, have always been considered unsuitable for coking, but it was essential for the prosperity of the district that the problem of their use should be solved. It was therefore studied simultaneously by the Carling collieries, the Thionville steelworks, the French Collieries' Study Center (CERCHAR) and at Marienau by a body jointly financed by the Steel Industry Research Institute (IRSID), the Lorraine Collieries, the Saar Mines Administration and the French collieries. The results so far have been encouraging and have been reported by Laurent.[24]

Ore Preparation and Sintering—So much importance is now attached to the accessory role of ore preparation and sintering that special interest was aroused by the second International Conference on Sintering held in Paris this year under the aegis of Institut de Recherches de la Siderurgie and Chambre Syndicale de la Siderurgie Francaise. The proceedings will be published (in French) by Chambre Syndicale in 1958, but meantime the leading papers are being serialized in a British Journal in English.[25] Thirty papers were submitted from France, Germany, Italy, Belgium, Sweden, Luxembourg, South Africa and Great Britain, providing material for a three-day conference.

During the first day, the mechanism of the sintering process was discussed, including studies of desulphurization, the effects of additions, and sinter properties. Many points which had been brought to light at the first meeting (London, November 1953) had been the subject of intense study between the dates of the symposia. For example, the roles of air, fuel, and heat transfer had been fully discussed at the first meeting and the reports presented at this year's meeting showed that, although all the phenomena had not been wholly explained, considerable progress had been made, particularly on the subject of heat transfer.

The design and operation of sinter plants were the over-all subjects for the second day, particular attention being given to the assessment of plant operation leading to accurate plant output rating. The use of sinter in blast furnaces when using both lean and rich ores was considered on the third day, papers being given by furnace operators. One contribution[26] provided valuable data on the position which arises before, during, and after a period when sinter was temporarily unavailable through a plant breakdown; the results reported the drop in furnace output and increase in coke rate during the period of no sinter.

As a result of these intensive investigations there can now be no doubt as to the importance of full ore preparation on the production of a blast furnace and its coke rate.

THE BLAST FURNACE

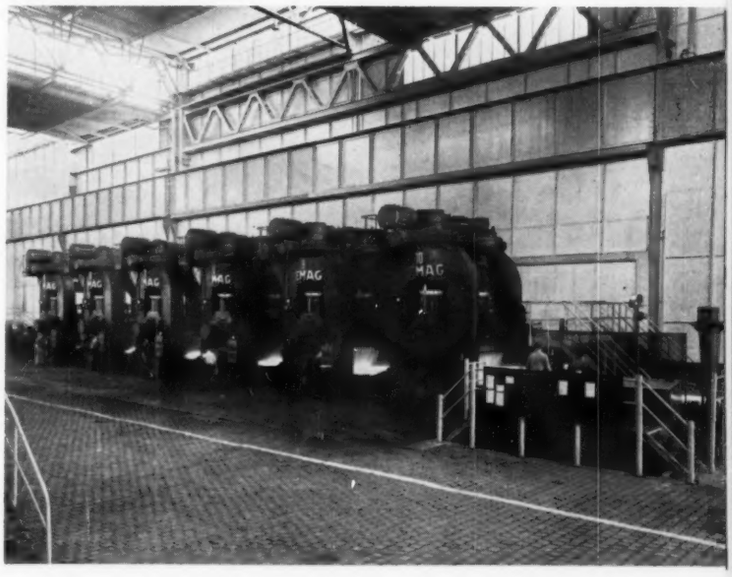
The hearth diameter of blast furnaces continues to be a point of interest and discussion all over the area, but without entering into lengthy discussion, it can only be said in a general way that the tendency is for hearth diameters to increase. A very useful "Survey of British Blast Furnace Practice" has been published by the British Iron & Steel Research Association pro-

Figure 32 — This six-stand hot finishing train, installed at the Ebbw Vale works, is believed to be the first of its kind in Europe.

vides data for comparison between the various sizes in use, and it is hoped by this means to acquire results which will throw light on the factors influencing productivity so that furnace performance can be assessed more realistically.

The performance of British blast furnaces in which the output increased from 7,000,000 net tons in 1945 to 13,200,000 net tons in 1955, accompanied by a steady fall in coke consumption, was not only due to re-equipment but also to technical advances in operation. Burden preparation has received particular attention by the Ironmaking Division of BISRA. Since there are wide variations in the consistency of iron ore it must be appropriately graded for efficient furnace operation. As in USA, considerable quantity of fines are still pro-

Figure 33 — Continuous wide strip mill at August-Thyssen-Huette, Duisburg has a scalebreaker stand; a four-stand, four-high roughing mill; and a six-stand, four-high finishing mill.



duced, however, despite improved methods of crushing, this problem is widespread throughout Europe. Reference may therefore be made to the paragraphs dealing with sintering, as this process has assumed an increasing importance all over Europe.

The conditions inside blast furnaces have also been made the subject of some interesting studies by BISRA, particularly in regard to happenings at and below the stockline. Radioactive tracers have been used to measure the transit time of gases through the furnaces, and studies have been made of the use of carbon as a refractory both in the hearth and as a lining for walls, bosh, and even the stack.

The subject of high top pressure is one of those to be discussed at a major conference in Europe next year, and as there will be other papers on blast furnace topics, fuller details of the meeting may be given, although some of the subjects to be dealt with are out of sequence here. The meeting is to be held from June 18–28 in Liege and Luxembourg, the participating bodies being Centre Nationale de Recherches Metallurgiques, Groupement des Industries Siderurgiques Luxembourg, Groupement des Hauts Fourneaux et Acieries Belge, and the Iron & Steel Institute. The general theme of the meeting will be "New Developments in Iron and Steelmaking," and a proposed list of papers follows:

The Bottom-Blown Converter. A general review paper on pneumatic processes. Two papers on French and German experience respectively.

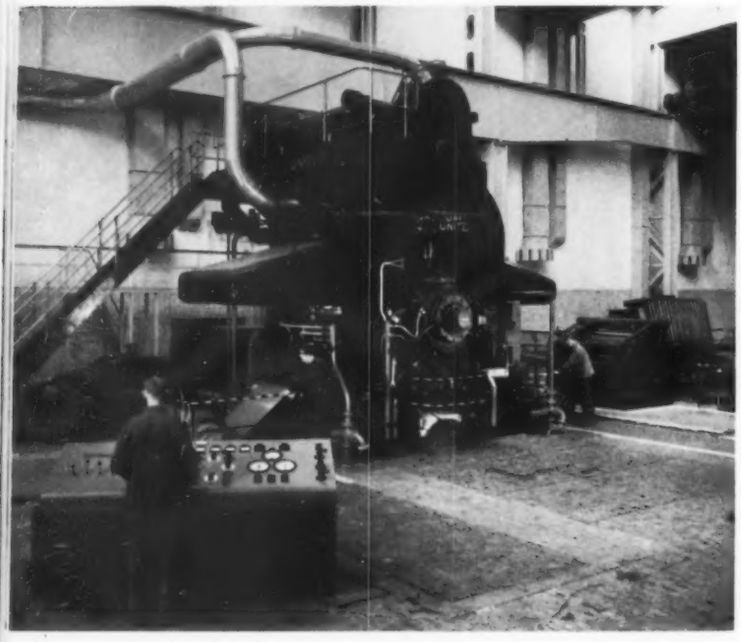
Top-blown Oxygen Processes. Papers on the L-D, Kaldo rotor and dual processes.

Steelmaking in the Open-Hearth Furnace. General paper on methods of increasing driving rate. Paper on recent U. S. developments.

Large Arc Furnaces. Paper on results achieved on the 165-ton arc furnaces. Paper on U. S. experience.

Low-Shaft Furnaces. General paper on operating results and experience.

Figure 34 — This 56-in. reversing cold strip mill was designed for rolling silicon steel at Surahammars Bruks A.B., Surahammar, Sweden.



New Direct Processes. Paper on developments in the USA and Canada. Paper on developments in Europe.

Blast Furnace Burden Preparation. General paper on beneficiation, sintering, pelletizing, extrusion, etc. Additional papers on Luxembourg, French, and Swedish experience respectively.

New Techniques in Blast Furnace Operation. General paper. Paper on U. S. experience in the use of oxygen and steam and high top pressure.

Theory of Continuous Casting and Developments of Experimental Machines. Papers on developments in the United Kingdom and in Europe respectively.

Industrial Applications of Continuous Casting. Papers on experience in the United Kingdom, France, Germany, Austria and the USA respectively.

Two interesting papers on the use of natural gases in the reduction of iron ores have appeared, one from Italy[27] and one from Switzerland.[28] The large natural gas resources in France and Italy have amply justified these researches and it seems to be now possible, as a result of pilot work, to draw up a provisional thermal balance for an industrial plant.

STEELMAKING

Dealing now with open-hearth developments, a model furnace with a calorimeter hearth that can operate at 2800 F has been built at the Sheffield laboratories of BISRA to give precise information on the relative values of radiation and convection and heat transfer in the open-hearth furnace.

Automation in respect of open-hearth furnace operation has been carefully studied, so that furnaces are now so fully instrumented as to be at least semi-automatic. Steelmaking is therefore becoming more of a science than a traditional craft, and attention could be directed to a manual on this subject which has been produced.[30]

Work on the basic bessemer processes has been greatly accelerated by the consumer demand for products which require steel qualities (e.g. drawability) unobtainable with traditional bessemer metal. Oxygen-enrichment of the blast[31] towards the end of the blow has provided valuable results in the reduction of the final nitrogen content of the charge, and by eliminating nitrogen entirely from the blow it is possible to drive the nitrogen in the charge down still further. However, since the use of pure oxygen in the bottom-blown converter tends to give refractory failure, work has been completed in Belgium on the substitution of another inert gas instead of nitrogen—either water-vapor or CO_2. This work is now operated on a commercial scale at the works of Esperence-Longdoz where the steels produced can have a nitrogen content as low as 0.002 per cent.[32]

Since oxygen plays such a large part in the development of the European iron and steel industry some brief notes may be given at this point, as to the present position. The literature on the general subject of oxygen is now literally tremendous, and the author has seen records of over 250 articles, papers, etc., published last year on the subject.

In general, development work in steelmaking which has included the use of oxygen, may be divided into the following main classes: (1) For pre-treatment, this

is mainly used in Britain in the open-hearth to minimize the metallurgical load; on the continent the purpose is to prepare iron normally unsuitable for the bessemer process. (2) For the pneumatic steelmaking process which started as straight enrichment of bottom-blown furnaces and is now culminating in processes which utilize top blown oxygen such as the L-D, Kaldo and Rotor. (3) Application to traditional open-hearth and electric furnaces for decarburization in both processes and for combustion air-enrichment in the open-hearth. (4) Further work may confidently be anticipated on the enrichment of the air blast for cupola and blast furnaces.

Pioneer work has been done at Brymbo Steel Works Ltd., with the co-operation of the British Iron & Steel Research Association, where ladles containing 18 tons of metal were blown with oxygen, using a ½-in. steel lance operating at a pressure of 150 psi. and a flow rate of 250 cfm. During the blow, which occupied from 15 to 20 min., the silicon was reduced from 0.80 to 1.50 to 0.40 to 0.60 per cent. Lime was added to form a mono-basic slag containing about 30 per cent lime and 30 per cent silica. It was possible to add about 5 tons of scrap to the ladle owing to the high temperature increment. When iron containing 1.50 per cent Si was treated, the efficiency of oxygen utilization was about 85 per cent, but was reduced to about 65 per cent when 1 per cent Si iron was treated.

Further work to remove phosphorous by oxygen at Brymbo has been reported by Davies,[33] in which he describes the technique developed at Brymbo works and gives recent results.

It is now established practice to refine open-hearth melts by the use of oxygen in the majority of works producing steels below 0.10 per cent carbon. The effect of using oxygen in the bath as a means of speeding the rate of carbon elimination has already been reported by Isaac,[34] who showed that in a 120-ton capacity basic open-hearth furnace producing steels of 0.02 to 0.03 per cent carbon the time taken to reduce the C content from 0.22 per cent without oxygen was 2½-hr, but when an oxygen lance was introduced the time fell to one hr.

Lances are difficult things to handle and Kesterton[35] has described the development at Steel Co. of Wales Ltd. in which oxygen is added to the bath by means of a water-cooled probe projecting into the furnace through the roof. This development is now well known in America.

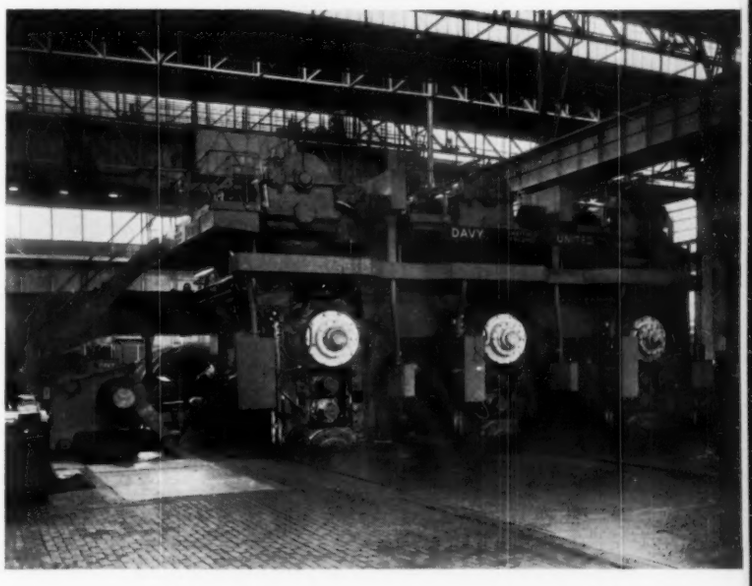
The use of oxygen for flame-enrichment has admirably reported by Jackson, Wogin & Johnson.[36] This is one of the most comprehensive articles the author has seen dealing with United Kingdom methods of the use of oxygen for assisted melting by flame-enrichment. Their investigations concerned hot metal tilting furnaces using 80 per cent hot metal in the charge. Tests were carried out on furnaces fired with pitch-creosote and coke-oven gas, and also mixed gas. The paper gives full details of a specific set of trials in which oxygen was used at the rate of 20,000 cfhr, the final one being undertaken to discover whether or not an increase in the oxygen flow rate and total oxygen consumption per ton would give rise to a further gain in the production rate. Consideration has been given to results on two furnaces using over 22,500 cfhr of oxygen. It was reported that an output gain of 5 per cent, equivalent to 130 tons of ingots per week per furnace, could be made under the conditions existing at the time of the trials using 25,000 cu ft of combustion oxygen per hour during scrap charging and up to the addition of metal (equivalent to 150 cu ft oxygen per net ton ingots).

The beneficial effects of the use of oxygen all over Europe has been greatly influenced by the fact that capital investment for plant is lowered to produce a given output. The increased efficiency of open-hearth operation has now been reinforced by many alternative steelmaking schemes, the most notable being the Kaldo[18] L-D [37, 38], and rotor.[39, 40] Where new construction is being considered, capital investment may thus now be reduced by decreasing the number of furnaces. Development of the use of the oxygen/steam blown Bessemer process[32] has now assumed considerable importance and has been particularly studied by Belgian and Luxembourg experts affiliated to the Liege section of C.N.R.M.

In the scope of this paper it is too much to examine the economic considerations of the general use of oxygen. This has been done very adequately by Clark & Harrison.[41] So encouraging is the economic picture that in Great Britain alone it is confidently anticipated that to reinforce the seven tonnage oxygen plants (both individual and distribution systems) now in operation a further 1000 tons per day of oxygen capacity will be installed in the next two years for the steelmaking industry by means of plants under construction or proposed. Tonnage oxygen plants are, of course, in use in many steelworks all over Europe. All Belgian and Luxembourg steelworks at which oxygen is available have stopped using atmospheric air alone and always use at least an oxygen-enriched blast, scrap being added either all together or at intervals.

Reverting now to the steelmaking process itself (although it is almost impossible to omit references to oxygen therefrom) interesting work is also being accom-

Figure 35 — This 80-in., three-stand tandem cold strip mill at the Abbey works of the Steel Company of Wales rolls 74-in. wide at speeds up to 2000 fpm.



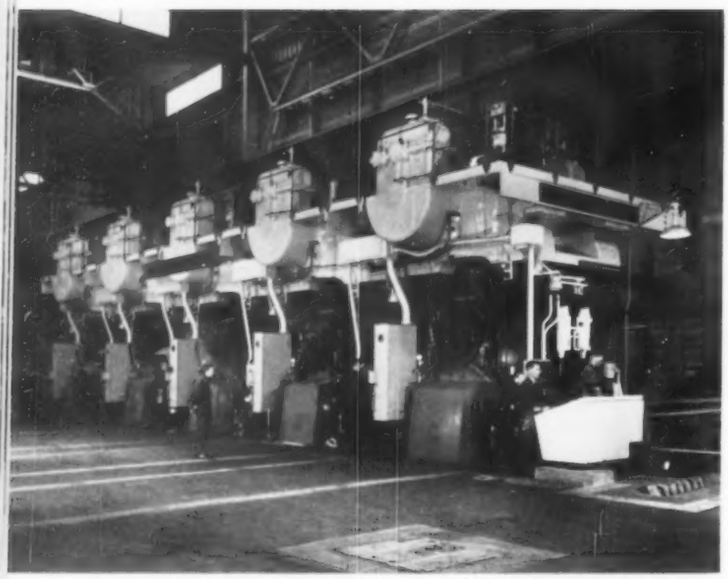


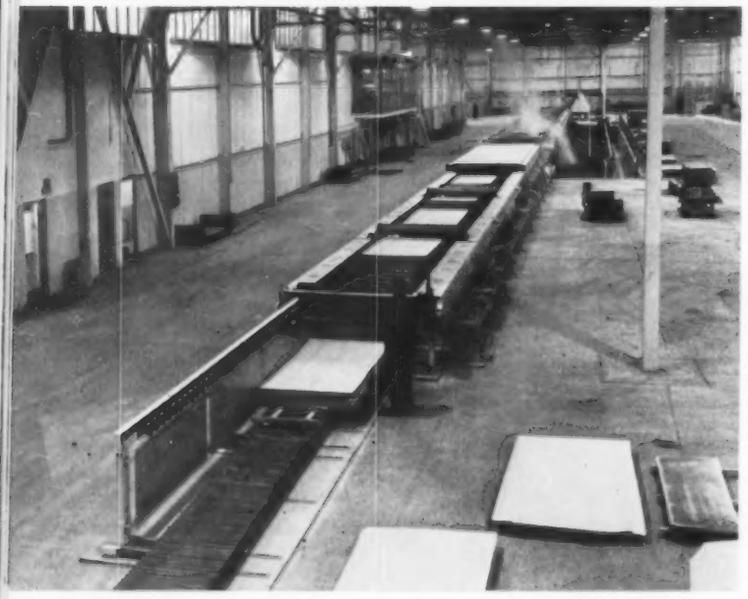
Figure 36 — In full production is a 42-in. five-stand continuous cold mill at the Steel Company of Wales, Ltd., Velindre works.

plished in Germany. The Max-Planck Institut (on which there is a further note later in this paper) report research on the metallurgy of the bessemer process, and the construction of a new drum converter with a capacity of some 660 lb. The bessemer pig iron required is remelted in a 660-lb high frequency furnace.

Particular stress has been laid on the development of a method for currently measuring the temperature in the immediate vicinity of the tuyere during the blow. It is intended to study in the converter the conditions which determine the course of carbon and phosphorus combustion and their interdependence.

The tasks dealing with the kinetics of the deoxidation of iron melts with silicon have been completed. Investigations have been extended to include deoxidation with manganese and silicon and also with aluminum.

Figure 37 — New plant was built for electro-coated finishes by a subsidiary of the Steel Company of Wales, Ltd. Operator has complete control of the line from the control panel.



In the metallurgical laboratory at Max-Planck, work on the fundamentals of the basic air-refining process has been undertaken on a broad scale. For this purpose a 66-lb Junkers graphite bar furnace was rebuilt into a basic small-size converter. Blowing with air or with oxygen-enriched blast, it was possible to achieve a fairly identical run of metallurgical reaction as in conditions of practical operation. Refining tests were carried out in this converter with the aim of burning carbon and phosphorus simultaneously, and thus reducing the final nitrogen content. In respect of the iron and phosphorus contents the final slags were similar to normal bessemer slags.

Further experiments concern the fundamentals of deoxidation, particularly the kinetics of deoxidation with silicon. Tests were made with linings of pure oxides. The results obtained indicate the strong influence of the crucible material both in respect of the silicon and oxygen contents of the melts and the separation speed of the deoxidation products.

Systematic research has been carried out by IRSID in collaboration with the Dauphine hydraulics laboratory on the optimum geometrical characteristics of basic converter linings and bottoms, with the object of reducing metal losses during blowing. A study was made of bath movements in the converter on small-scale models, and various French steelworks co-operated. As a result, new converter profiles are proposed; very full conclusions from the whole research have been widely reported.[42, 43]

For efficient blowing in the converter, production conditions must be regulated accurately, continuous measurement of temperature being necessary. A new type of pyrometer, proposed as a result of extensive research by IRSID, has been successfully tested at the Moyeuvre plant of the Societe des Establissements de Wendel. Work on this subject has also been accomplished by the Max-Planck Institut in conjunction with Dortmund-Horden-Huttenunion, who report that there has been successfully developed a radiation pyrometer for temperature measurement and a recording flame spectrometer for observing the progress of the reaction. As a result of combined evaluation of the two measurements the desired composition can be reliably and uniformly maintained by pouring at the correct time and avoiding overblowing.

The International Committee on Flame Research regularly report results[44, 45] on work at an experimental research station at IJmuiden (Holland). Many industries participate in and are affected by this research, but it is only in recent years that productivity in the European steel industry has benefited. Particularly interesting results are now emerging, especially in regard to open-hearth furnaces, fuels, productivity, comparison of solid and liquid fuels, and premature wear on certain parts of the furnace.

A word must be said about the cyclosteel process, although available data on it as published are meager and not always well informed. In fact, the development work is being steadily pursued by BISRA, so that only their announcements as to progress are valid.

The situation is, however, that an intensive period of exploratory work has been completed to obtain data for the erection of a small-scale pilot plant. This is under way, but naturally the ideal form that this plant

will take is not easy to determine in the initial stages. As a necessary preliminary, the behavior of fine partially reduced ores carried in hot gases was studied with particular reference to the question of build-up and blockage in ducts, cyclones, etc. at certain temperatures. It has been established that accretions and blockages are not likely to occur at temperatures below 1550 F if conveying velocities are high enough to prevent any particles settling.

The cyclosteel process as at present envisaged will be in two distinct stages; a preheating and pre-reduction stage, followed by a final reduction and liquid-metal slag separation stage. The possibility of carrying out the first stage in a shower furnace has been investigated. Mixtures of powdered ores and coal have been dropped down an externally heated vertical shaft 10 ft high. The gas flow has been adjusted to allow the product gases to flow in the same and in opposite directions to the solids and also to permit the addition of reducing gases. Such a furnace must operate at temperatures below 1550 F or above 2300 F in order to avoid blockages. Below 1550 F the degree of reduction was small. Above 2300 F, about 40 per cent of the combined oxygen was removed from the ore in a single pass, but the refractories were severely attacked, and this constitutes a limitation which cannot be overcome with present-day refractories. A pre-reducing stage carried out below 1550 F will require longer reaction times and greater control than is possible with the shower furnace. Further developments are now awaited with great interest.

This section would not be complete without reference to "brown fumes" caused by even the partial replacement of air or iron ore by oxygen as an oxidizing agent. This threatened to be a serious problem, but with characteristic energy it has been tackled by research workers. Work carried out at the works of Societe Metallurgique de Normandie (Mondeville) by IRSID has proved almost completely effective when concerned with the prerefining of basic pig, and the installation which was set up could treat 40 tons of metal and draw off 17,000 cu meters of fume. The most original and effective part of the plant is the washing installation.[46]

At the VOEST steelworks at Linz, a wet cyclone plant has been installed for dedusting the brown fumes from the oxygen-blown converter.[47]

MECHANICAL WORKING

From the soaking pits to the final finished stage the most spectacular story in the development of European steel production is that of "bigger and better plant." Each increase in size of the plant required to produce finished and semi-finished products has increased the difficulties of achieving a final product conforming to present-day exacting standards, and it is only by the loyal co-operation of the plant engineers and the research staffs collaborating with them that the present high quality results have been attained.

The screwdown method of automatic gage control devised by BISRA is now being marketed commercially and is already well known in the USA. The first installation has been made in Britain on the cold reduction mills at the Lancashire & Corby Works of Stewarts and Lloyds Ltd., and the results so far obtained indicate that this type of automatic gage control will keep the coil very closely to the required constant gage along its whole length. The importance of accurate gage in flat-rolled products need not be emphasized.

Current rolling mill work, however, has moved on from the foregoing to the operation and control of continuous multi-stand mills. A miniature three-stand mill has therefore been built and installed at the Sheffield laboratories of BISRA to investigate theories for improved design, operation and control of tandem mills. An unconventional feature of this mill is that the electrical and mechanical characteristics of each stand, and the distance between stands, are infinitely variable; the wide range of studies that can be made will therefore be apparent, and among these may be noted stability of operation and control simplification. Drafting schedules can also be compared, while further systems of automatic gage control can be studied for tandem mills.

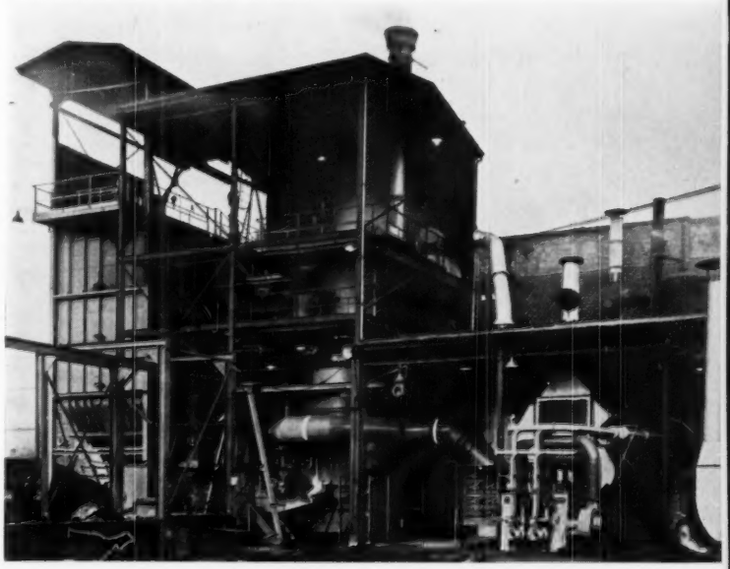
This work on flat-rolled products also provides an excellent example of co-operative research, in this case between the Swinden laboratories of The United Steel Companies Ltd., and BISRA, whereby fundamental work on roll pass design is being carried out using both plasticine and hot steel on BISRA's 6-in. mill.

Further work includes a comprehensive survey of existing rod mills and rolling practice in collaboration with firms throughout the country, with the object of developing designs that will provide high output along with such qualities as dimensional accuracy. Many interesting problems should be revealed by this survey.

In the rolling mill field, particular attention has been directed to the installation of the planetary mill, two of which are now in operation in Great Britain. The general design of these mills is now well known, but the story of how they have come into service and their present performance could provide a paper of immense interest to rolling mill technicians all over Europe. It is to be hoped that this contribution will be made.

Another interesting design is the steckel rolling mill

Figure 38 — As a result of studies on the low-shaft furnace, a pilot plant has been built.



installed at Dudelange (Luxembourg) on which a report has been made by Hamus.[48] The design and operation of this mill is not well known to technologists and will be of special interest to members attending the Joint Metallurgical Conference which will visit Luxembourg next year. This mill is suitable for plants where the amount of steel to be processed is not very large, requiring, as it does, less space for installation and being more flexible. Eight of these mills are now in service as compared with two before the war.

A very comprehensive program is in progress under the aegis of IRSID, important sections dealing with plasticity of metals, general performance of the blooming mill (being accomplished at Thionville), and the problems associated with cold rolling, e.g. interstand tension and its influence on final thickness. All this work is being accomplished in close collaboration with the High Authority of ECSC, and many interesting reports have already been made.[48, 49, 50]

It is now more easily possible to keep informed of the important work of the Max-Planck Institut fur Eisenforschung, since annual reports have been appearing regularly since 1954. Hitherto all reports of the Institut appeared in "Archiv fur Eisenhuttenwersen" and "Stahl und Eisen," and these have formed an impressive record of work accomplished. Before the war the German structure of research proceeded in ordered stages from the basic work undertaken at universities, via the large-scale research facilities at the steelworks on to the works laboratories, with Max-Planck in the clearly defined role of intermediary between pure research and its application at the steel mills. The foundations of this structure are now completely destroyed, and the loss of the research installations of the big concerns represents a gap that has made itself increasingly felt in the reconstruction efforts of the works. Heavy demands have therefore been placed on the Institut for direct co-operation in operational research and the trend of this work in rolling, as in other spheres, has been clearly apparent in the work that has been published.[51]

As an example of engineering development the combined bar and wire rod rolling mill installed at Morgardshammar (Sweden) is notable. This replacement of what formerly consisted of several mill units by one combined rolling mill has resulted in lower capital costs, and, being extensively mechanized, fewer operators are required. Particular attention is directed to the new type of roller guide that is used, the rollers being held in position by means of laminated springs. The plant is extensively reported by Norlindh.[52]

The collaboration between research staffs and the plant engineer is shown by what is claimed to be the largest and heaviest plate mill in Europe, at Heinrichschutte, Hattingen, Germany. This 13-ft four-high design, with vertical edger, was put into commission last year, and the problems of casting the 410-ton housings could form the subject of a complete paper. The largest known roll neck bearing is used.

An extensive examination of automatic gage control during rolling has been published by Blain.[50] He has examined all the published systems proposed and finally concludes that if the most valuable of the principles evolved from all these theories and researches are to be applied in practice, it will be necessary to use types of rolling mill very different from those produced at present.

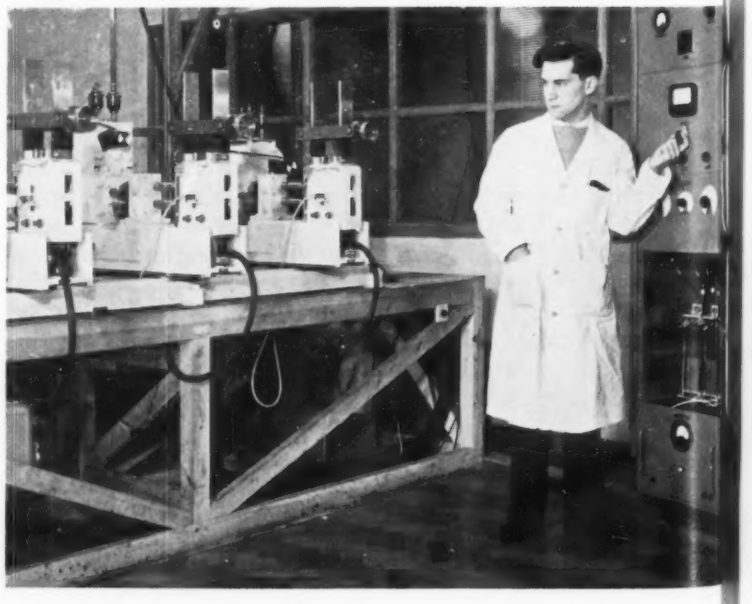
Figure 39 — Heavy equipment section of the Sheffield laboratories of BISRA.

SUMMARY

This general review of plant and processes in the European area will almost certainly be notable for what it has left out! So much work, both in the plants and the laboratories, is continually being reported that the story is changing—literally daily—always with a forward regard for higher output tonnages and improved quality. Great credit is due to plant engineers and scientists everywhere for the success of their efforts.

Quality has been steadily improved, both in substance and in finished (or semi-finished) accuracy. The ideal condition of complete consumer satisfaction will never be reached, but difficulties such as exist in ore,

Figure 40 — A model three-stand mill is shown in BISRA's Sheffield laboratories.



scrap, or coal supply have been accepted and faced with resolution. Demand is not expected to diminish, so that with more money being spent on development plans, the research worker was never so busy, nor were his opportunities ever so wide.

In all the re-equipment plans mentioned, great credit is due to the "elder statesmen," in experience as well as age, who have had to keep the pattern of demand continually under review and if, sometimes, there have been shortages, due frequently to local conditions, the steel consuming industries all over Europe have much for which to be thankful.

It would be difficult to over-rate the importance of the contribution that has been made by the United States of America to the re-equipment of the European steel industry. Not only in quantity, which has been very considerable, but also in quality such plant (and if the author particularizes rolling mills, it is only because these are his particular interest) has both encouraged development schemes in progress and helped to give the consumer material of the standards he has demanded.

Productivity in the European area is rising, encouraged by the receptive attitude of those operating plant, but ably reinforced also by research teams, plant engineers and the new management. This subject would make a paper of itself, so also would the improved standards of living that are following on all the increased activity, the rehousing schemes and movement of personnel, the overall problems of investment, the general location of new plants (seaboard etc.), and the wider uses that are now being made of steel—particularly in sheet form.

ACKNOWLEDGMENTS

For generous assistance with data for the compilation of this review the author is greatly indebted to many friends all over Europe, including Chambre Syndicale de la Siderurgie Francaise, Institut de Recherches de la Siderurgie, Associazione Industrie Siderurgiche Italiane, British Iron & Steel Federation, British Iron & Steel Research Association, and the European Coal & Steel Community.

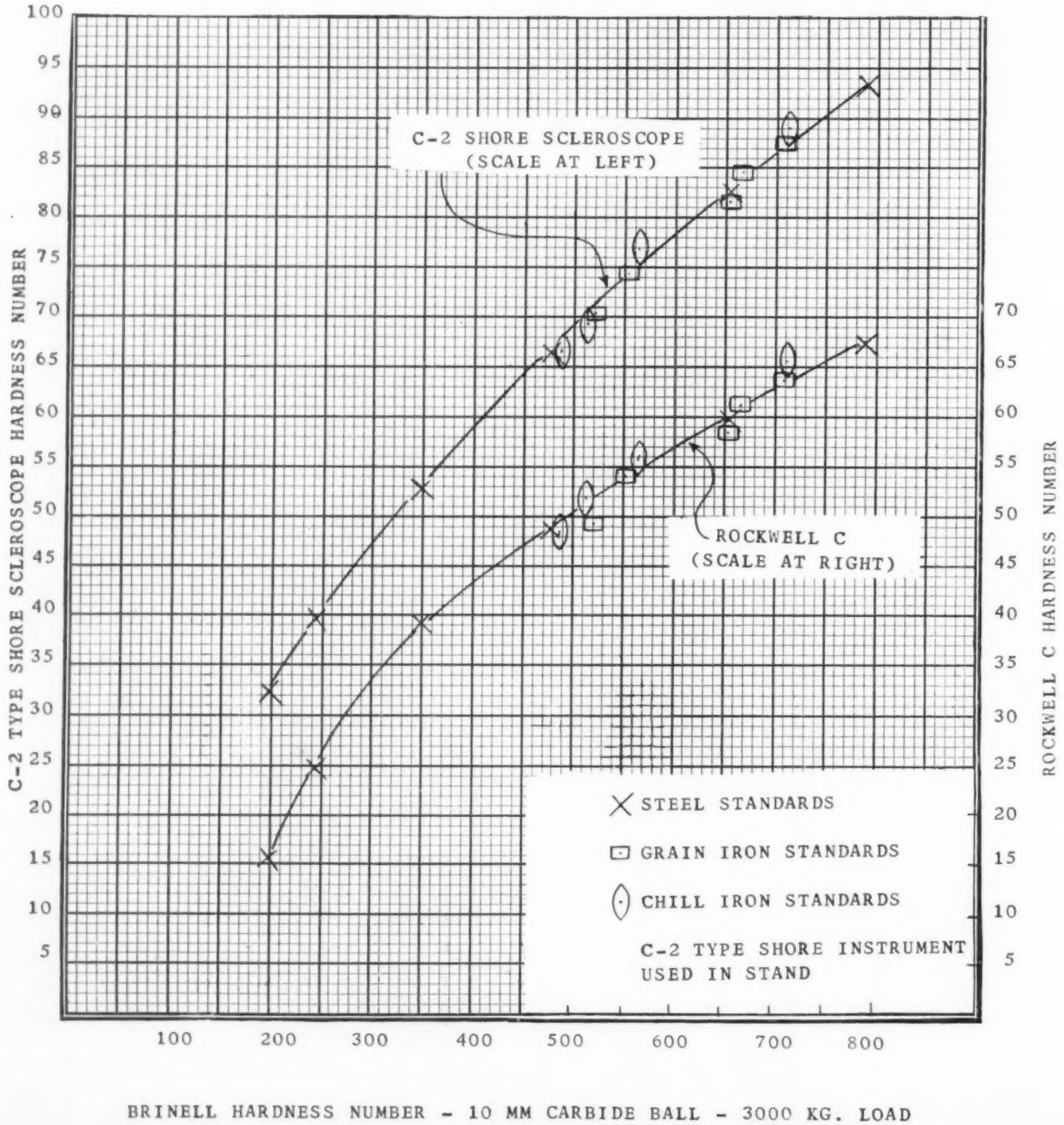
Grateful appreciation for the illustrations used is also expressed to Davy & United Engineering Co. Ltd., Demag AG., the British Iron & Steel Federation and their photographer, Adolf Morath.

BIBLIOGRAPHY

1. *"Sir Henry Bessemer, 1813–1898,"* by James Mitchell, C.B.E., Bessemer Centenary Lecture, Jnl. Iron & Steel Inst., June, 1956.
2. *"Sir Henry Bessemer,"* by D. Bessemer, Jnl. Iron & Steel Inst., June 1956.
3. *"Sir Henry Bessemer—Inventor and Businessman,"* by Georges Delbart, Jnl. Iron & Steel Inst., June 1956.
4. *"The Use of Oxygen in Steelmaking,"* by Folke Johansson, Stockholm meeting of Jernkontoret, May 1956.
5. *"The Life of Andrew Carnegie,"* by Burton J. Hendrick, Heinemann, London, 1933.
6. *"Steel & Britain's Future,"* Industrial Newspapers Ltd., London, 1949.
7. *Development of the Iron & Steel Industry,"* 1953–58, Report by Iron & Steel Board, H. M. Stationery Office, London.
8. *"Technical Survey of The Steel Company of Wales Ltd.,"* Industrial Newspapers Ltd., London, 1951.
9. *"Technical Survey of the Consett & Jarrow Plants of The Consett Iron Co. Ltd.,"* Industrial Newspapers Ltd., London, 1954.
10. *"Technical Survey of the Hawarden Bridge Steelworks of John Summers & Sons Ltd.,"* Industrial Newspapers Ltd., London, 1953.
11. *"Technical Survey of Appleby-Frodingham Steel Co.,"* Industrial Newspapers Ltd., London, 1955.
12. Iron & Coal Trades Review, August 16, 1957.
13. Developments in the Iron & Steel Industry, Special Report 1957, H. M. Stationery Office, London.
14. Iron & Coal Trades Review, August 24, 1951.
15. J. Oberregger, Technical conference Eisenhutte Osterreich, Leoben, June 1957.
16. Iron & Coal Trades Review, August 24, 1951.
17. Iron & Coal Trades Review, October 28, 1955, p. 1007.
18. *"Work on improvement of basic Bessemer steel at Domnarfvet Steelworks,"* by Bo Kalling, Revue Universelle des Mines, Vol. 92, series 9, August 1953.
19. H. G. Sohl, Financial Times Special Survey, May 27, 1957.
20. Stahl und Eisen, March 21, 1957.
21. H. G. Sohl, General address by chairman Wirtschaftcereinigung, June 6, 1957.
22. Resultats d'une annee de recherches sur le bas fourneau (1953–54), by Comite International, Revue Universelle des Mines, February, 1955, No. 2, p. 45–67. Publication IRSID, serie A, March, 1955, No. 98, 23 pp.
23. D'apres le Comite International (Pig iron made from low-grade fine ore and non coking coal), Metal Progress, January, 1955, No. 1, p. 81–86.
24. *"The Coking of Lorraine Coals,"* by L. Laurent, Advances in Steel Technology, Vol. 1, 1955. United Nations.
25. Iron & Coal Trades Review, June 14, 1957.
26. P. Ledgard, D. Rist, P. K. Gledhill, Iron & Coal Trades Review, August 2, 1957.
27. *"Reduction of Iron Ores by Natural Gas,"* by A. Scortecci, Advances in Steel Technology, 1955, United Nations.
28. *"The Use of Natural Gas in the Reduction of Iron Ores,"* by H. Galluser, Ibid, p. 99.
29. Kosmider & Wedel, Blast Furnace & Steel Plant, May 1956.
30. *"Instrumentation of Open-Hearth Furnaces,"* Handbook by BISRA, London.
31. *"Use of Oxygen-enriched Air in the Thomas Converter,"* by L. Marbais, A. Grosjean, G. Hotot, M. Poverman, Recherches Travaux, Centre National Recherche Metallurgique Belge, No. 1.
32. *"Use of Oxygen-Steam Mixture in Steelmaking,"* work proceeding at Esperence Longdoz Works, Belgium.
33. E. Davies, Iron & Coal Trades Review, Vol. 172, 1956.
34. S. R. Isaac, Iron & Coal Trades Review, Vol. 168, 1954, p. 1479.
35. A. J. Kesterton, Iron & Coal Trades Review, Vol. 168, 1954, p. 1480.
36. W. Jackson, R. Wogin, R. Johnson, Iron & Coal Trades Review, Vol. 171, p. 889.
37. *"Three Years of L-D Steel,"* Published VOEST, Co. Linz.
38. *"The L-D Process in Austria,"* by B. Matuschka, Jnl. of Metals, Vol. 8, No. 6, 1956.
39. *"The Rotor Steelmaking Process,"* by R. Graef, Stahl und Eisen, January 10, 1957.
40. *"The Rotor Steelmaking Process,"* by K. Heinrich, Iron & Coal Trades Review, Vol. 171.
41. *"Tonnage Oxygen in Steelmaking,"* by F. J. Clark, J. L. Harrison, Jnl. Iron & Steel Inst., July, 1957.
42. P. Leroy, Revue de Metallurgie, September, 1952, No. 9, and October 1952, No. 10.
43. P. Leroy, Revue Universelle des Mines, August, 1953, No. 8.
44. M. P. Newby, J. D. Tyler, Chaleur et Industrie, July, 1952.
45. M. W. Thring, D. Smith, Jnl. Iron & Steel Inst., March, 1955.
46. French Patents No. 1136,128; 620,429; 50,479.
47. *"Twelve Months Experience In Converting With The L-D Oxygen Blowing Process,"* paper issued by VOEST Co., Linz, Austria, 1954.
48. *"L'Application de la Theorie de la Plasticite au Faconnage de Metaux,"* by Lerebours & Pigeonniere, Metaux et Corrosion, March, 1957, No. 319, Conferences CESSID 1953.
49. *"Methodes de Mesures des Temperatures au Cours du Laminage,"* by Rhone & Rodicq, to be published.
50. *"Regulation Automatique de L'epaisseur des Produits au Cours de Leur Laminage,"* Revue Generale de Mecanique, Jan. & Feb., 1957.
51. Max-Planck Institut fur Eisenforschung, Annual Report, 1956.
52. Norlindh, Advances in Steel Technology, 1955, United Nations publication. ▲

Relationship Between Scleroscope, Rockwell, and

Figure 1 — Curves show conversion between Scleroscope, Brinell, and Rockwell hardnesses.



by N. R. ARANT, Technical Director, Roll Manufacturers Institute, Pittsburgh, Pa., and
J. J. MARSALKA, Foundry Superintendent, National Roll and Foundry Co., Avonmore, Pa.

Brinell Hardness Readings

. . . . an elaborate and careful series of tests show that consistent hardness values can be obtained on several types of iron rolls . . . . a definite relationship exists between the roll material hardness values obtained from these tests which appears to be the same as that on steel . . . . as a result, ASTM conversion tables can probably be used for roll materials . . . .

AN investigation was conducted by the Roll Manufacturers Institute to develop a conversion curve for Scleroscope-Rockwell-Brinell on chill iron, grain iron and carefully heat-treated standard carbon-steel bars. This investigation was conducted in two phases; the first phase under the supervision of Howard B. Myers and the second phase under Joseph J. Marsalka.

In the first phase, steel bar standards were used in correlating the general duty Shore direct reading (C-2) Scleroscope with the Rockwell C hardness tester. More than 2200 readings were recorded by 37 operators, one of whom was common to each of the 18 C-2 type instruments used. In the second phase, chill iron, grain iron and steel bar standards were used to correlate the C-2 Scleroscope instrument with the Rockwell C and the Brinell hardness tester. The number of Scleroscope readings totaled more than 8300. For this part, 20 C-2 type instruments were used and 30 operators participated—one common to each of the instruments.

The method used for making steel standards was the same as that used by Kommel ("Variables of the Shore Hardness Test," by Kommel, A. R., United Effort, July 1945, pp. 8–9) whose method consists of carefully heat-treating five 1.00 per cent carbon steel bars (1¼ x 1¼ x 3 in.) to various hardness levels, surface grinding to a fine finish and making Rockwell hardness tests on all four large faces of each bar.

In the investigations supervised by Myers and Marsalka, six 1.02 per cent carbon steel test bars of various hardness were prepared in the same manner and checked for hardness on a standard Rockwell machine, and for the Brinell hardness by the ASTM method (E 10 – 50 T) with a carbide ball.

The five grain (indefinite chill) iron bars were cast horizontally, with one face against a chiller plate and the remaining faces in dry sand, whereas the four chill iron bars were cast upright in an iron mold. To obtain differences in hardness, each chill iron bar (2 in. square x 8 in. long) was made with a different carbon content, whereas each grain iron bar (2 in. square x 12 in. long) was made with a different alloy content. The bars were surface ground to a fine finish on a chilled face and the one parallel to it, before standardizing on the chilled face with Rockwell and Brinell hardness testers.

The standard bars were taken to each member plant of the Roll Manufacturers Institute and checked for Shore Scleroscope (C-2) hardness with as many operators and instruments as practical. The Scleroscope instruments were mounted in a regular Shore stand placed above the leg of a layout table or on a metal face plate. In testing the steel bar standards, each of the operators (one common to all instruments) made a series of ten readings on each test bar. These readings were spaced as follows: two on the first 1¼ x 3 in. face; three on the second; two on the third and three on the fourth. The arithmetic mean of the ten readings obtained for each bar by an operator was recorded as the C-2 Scleroscope hardness number observed by him for that bar. In testing the iron bar standards, the ten readings per bar were taken on a chilled face. Then, the grand average of all C-2 Scleroscope hardness numbers for each bar were determined for the standard operator who used all instruments and for the group of operators who used only one instrument. This was done for both Phase I and Phase II.

The data taken showed the excellent check obtained by one operator with 18 instruments, and 36 operators with 18 instruments during Phase I, and also by one operator with 20 instruments and 29 operators with 20 instruments during Phase II, which was conducted three years afterward.

The grand-average curves for Scleroscope-Brinell and Brinell-Rockwell C are shown in Figure 1 for the data from Phase II. These curves include data for steel, chill iron and grain iron bar Standards. Each point plotted represents approximately 600 Scleroscope readings. To convert from Scleroscope to Rockwell C move from the Scleroscope scale across to the Scleroscope curve, down to the Rockwell C curve, and across to the Rockwell scale.

The conversion curves are valid specifically for the general duty C-2 Scleroscope and not the Roll C Scleroscope. ▲

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, March 31, 1958—Dinner 6:30 P.M.,
Meeting 8:00 P.M.

"Regeneration of Waste Pickle Liquor," by James S. Joseph, Sales Engineer, Koppers Co. Inc., Engineering and Construction Div., Chemical Dept., Pittsburgh, Pa.

Thomas Jefferson Hotel, Birmingham, Ala.

BUFFALO SECTION

Tuesday, March 11, 1958—Dinner 6:30 P.M.,
Meeting 8:00 P.M.

**"From Ingot to Ingot in Fifteen Days—
Replacing a 27-In. Universal Slabbing Mill with a 38-In. x 66-In. Universal Slabbing Mill on the Same Site,"** by D. H. Sampson, Mechanical Engineer, Dominion Foundries & Steel, Ltd., Hamilton, Ontario, Canada

Hotel Sheraton, Buffalo, N. Y.

CHICAGO SECTION

Tuesday, March 4, 1958—Dinner 6:15 P.M.,
Meeting 7:45 P.M.

"Process Programming in Steel Mills," by H. G. Frostick, General Supervisor Design Engineering (New Mills Construction) South Works, United States Steel Corp., Chicago, Ill., E. H. Browning, Manager, Metal Working Section, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa., and W. M. Brittain, Manager, Digital Development Systems Control Dept., Westinghouse Electric Corp., Buffalo, N. Y.

Phil Smidt's Restaurant, 1205 N. Calumet Avenue, Hammond, Ind.

CLEVELAND SECTION

Tuesday, March 18, 1958—Dinner 6:30 P.M.
Meeting 8:00 P.M.
Paper data not available
The University Club, 3813 Euclid Avenue, Cleveland, Ohio

DETROIT SECTION

Tuesday, March 11, 1958—Dinner 6:00 P.M.,
Meeting 8:00 P.M.
Great Lakes Steel Corporation Night
Twentieth Anniversary—Detroit District Section—AISE

"Use of Taconite Pellets in a Blast Furnace"

Dearborn Inn, 20301 Oakwood Blvd., Dearborn, Mich.

LOS ANGELES SECTION

Monday, March 10, 1958—6:30 P.M.

"Fabrication and Installation of the Tramway Across the Grand Canyon"

Michaels Restaurant, 6309 East Washington, Los Angeles, Calif.

PHILADELPHIA SECTION

Saturday, March 1, 1958—Dinner 6:00 P.M.,
Meeting 7:00 P.M.

New Operational Features on Patricia Blast Furnace at Fairless Works:

"Basic Characteristics," by R. H. White, Superintendent Blast Furnaces, Fairless Works.

"Electrical Controls," by W. O. Smith, Electrical Engineer, Fairless Works.

"Instrumentation," by P. E. Hutchings, Fuel Engineer, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

"Recent Innovations in Blast Furnace Maintenance and Rebuilding," by Louis Torok, Planning Engineer, Bethlehem Steel Co., Bethlehem, Pa.

Engineers Club, 1317 Spruce Street, Philadelphia, Pa.

PITTSBURGH SECTION

Monday, March 10, 1958—Social Hour 6:00 P.M.,
Dinner 7:00 P.M., Meeting 8:00 P.M.

"Pre-Cast Panel Construction for Furnaces," by E. W. Garvin, Jr., Vice President-Sales, and R. J. Demaison, Vice President and Technical Director, Quigley Co. Inc., New York, N. Y.

"Progress in Developing Fire-Resistant Hydraulic Fluids," by Samuel P. Polack, Mining, Health and Safety Engineer, Health and Safety District B, Bureau of Mines, U. S. Department of the Interior, Pittsburgh, Pa.

University Club, University Place, Pittsburgh, Pa.

ST. LOUIS SECTION

Wednesday, March 26, 1958—Social Hour 6:00 P.M.,
Dinner 7:00 P.M., Meeting 8:00 P.M.

"Many Circuits over Two Wires," by J. W. Bauer, Jr., District Sales Manager, Femco, Inc. Irwin, Pa.

Elks Club, Granite City, Ill.

SAN FRANCISCO SECTION

Tuesday, March 18, 1958—Social Hour 6:00 P.M.,
Dinner 7:00 P.M., Meeting 8:00 P.M.

Pacific States Steel Corp. Night

"12-In. Mill at Pacific States Steel," by E. C. Thomas, Plant Manager, Pacific States Steel Corp., Niles, Calif.

Shattuck Hotel, Shattuck & Alston Way, Berkeley, Calif.

UTAH SECTION

Monday, March 10, 1958—Social Hour 6:30 P.M.,
Dinner 7:30 P.M., Meeting 8:30 P.M.

"Two Generations of Sheet & Tin," by W. A. Marshall, Works Engineer, Pittsburg Works, Columbia-Geneva Steel Div., United States Steel Corp., Pittsburg, Calif.

Sir Lesters, Salt Lake City, Utah

YOUNGSTOWN SECTION

Monday, March 24, 1958—Social Hour 6:00 P.M.,
Dinner 7:00 P.M., Meeting 8:00 P.M.

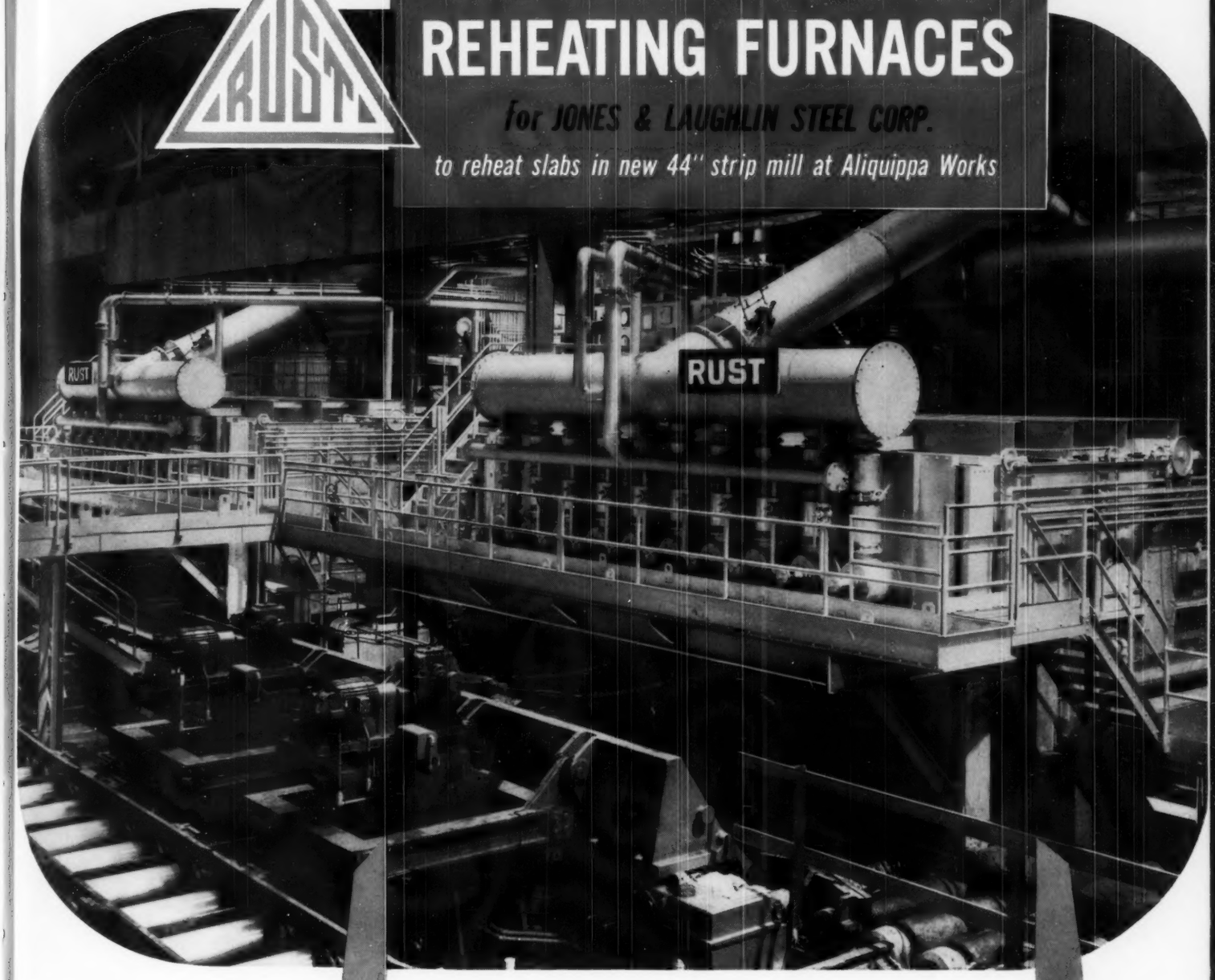
"Steel Mill Lighting," by C. M. Crysler, Illuminating Engineer, Lamp Div., General Electric Co., Pittsburgh, Pa.

Mahoning Country Club, Girard, Ohio

TRIPLE-FIRED CONTINUOUS REHEATING FURNACES

for JONES & LAUGHLIN STEEL CORP.

to reheat slabs in new 44" strip mill at Aliquippa Works



Two completely automatic gas-fired Rust furnaces, designed and constructed for the new 44" strip mill at J&L's Aliquippa Works. Each furnace heats cold slabs to rolling temperatures at a rate of approximately 150 tons per hour. Furnace temperatures range from 1650° F. at the entry end to about 2400° F. at the discharge end. The internal dimensions of the furnace are 26′ wide x 92′ long. There are 26 burners in each furnace, arranged in three zones. One set is at the discharge end, one set is above and one below the primary heating zone. Metallic recuperators help to boost capacity and minimize fuel consumption.

This zone-fired type of Rust furnace is used by virtually all strip mills throughout the world. Rust also builds all other types of metallurgical furnaces, designed for any fuel. Consult us about your requirements.

THE WHOLE JOB IS ONE JOB WITH A "RUST PACKAGE CONTRACT"

One contract covers everything from original idea through furnace start-up. One responsibility for design, manufacture, erection and initial operation. One overhead and profit (with substantial savings to you) on all phases of the work, including wiring and piping.

Rust Furnace Company

930 FORT DUQUESNE BOULEVARD, PITTSBURGH 22, PA.

Pioneers in Furnace Design

F 22

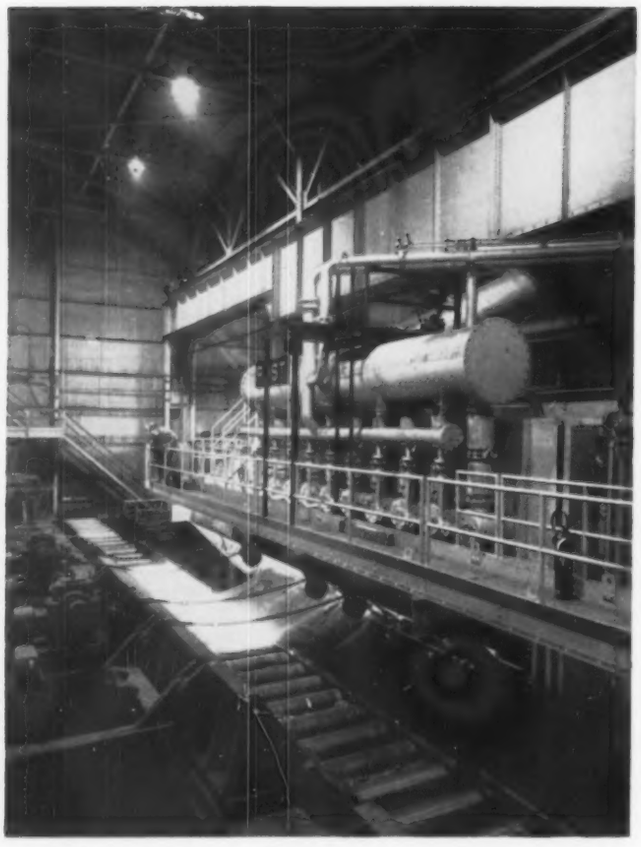


Figure 1 (left) — The new 44-in. semi-continuous hot strip rolling mill has two reheating furnaces, each rated at 150 tons of slabs per hr. Figure 2 (right) — Automatic control of new roughing reversing mill begins when the mill operator inserts a standard punched card in this IBM card reader. When operator presses a pushbutton, information is extracted from the card and stored. When operator presses a second button the mill begins its predetermined cycle of automatic operations.

J & L Starts Operation of

A NEW 44-in. semi-continuous hot strip rolling mill, the first in the steel industry with a fully automatic programmed control system on the reversing rougher, has been put into production by Jones & Laughlin Steel Corp.

The new facility, installed at J & L's Aliquippa Works, Pa., at a cost of more than $36,000,000, will be able to roll over 100,000 tons of coiled strip steel per month. The product—coiled strip steel in varying gages and up to 40 in. in width—will be used primarily in the electricweld and continuous weld pipe mills, and in the manufacture of tin plate at the Aliquippa Works.

The strip mill is designed to roll a slab equal to the full product of an ingot on most sizes and grades. The mill can roll coils weighing up to 20,000 lb.

Reversing rougher speed and maximum weight of slabs are more than ample to maintain the desired rate of tonnage in the finishing end of the mill.

The new mill, consists of a vertical scalebreaker, a two-high reversing roughing mill with the attached edgers, six four-high finishing stands with three individually-driven edgers, and two revolving-mandrel downcoilers.

A continuous record of the thickness and width of the strip is obtained immediately after passing the No. 6 finishing stand, by means of X-ray and width gages.

Maximum versatility for the new mill has been provided in the electrical installations. Every motor from the entry table of the reversing rougher through the finishing stands, the runout tables and through the downcoilers is an individual drive.

Controls for the mill are located in three pulpit positions. The card reader, an IBM machine which transmits scheduling information from the IBM cards to Prodac's memory and decision making equipment, is located in a raised pulpit in the immediate vicinity of the reversing rougher. This information handling equipment is located in the mill's motor room. The finishing stands are controlled from the speed-operator's pulpit which is directly across from these six stands. The downcoilers are operated from a separate pulpit.

The new mill is located near the Aliquippa Works' blooming mill. Two hot-scarfing units for blooms and slabs were installed at the blooming mill, as well as transfer facilities to the strip mill. These facilities permit the direct rolling of hot slabs without reheating. In addition, two new heating furnaces, rated at 150 tons of slabs per hr,

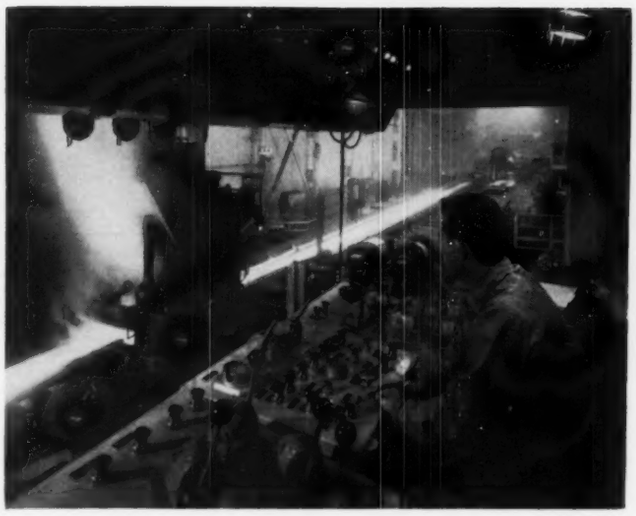
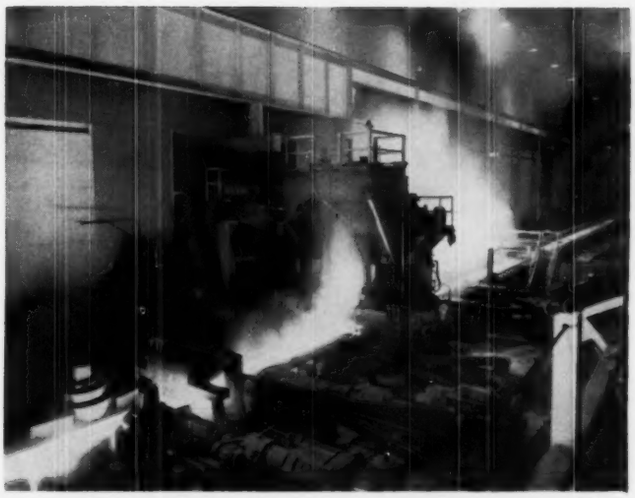


Figure 3 (left) — The reversing rougher operator of the new 44-in. semi-continuous hot strip rolling mill has little to do when the reversing rougher is controlled by programmed digital automatic control. Figure 4 (right) — The reversing rougher is a twin drive with each roll driven by a 3000-hp motor. Attached edger is driven by two 375-hp AISE 622 mill motors.



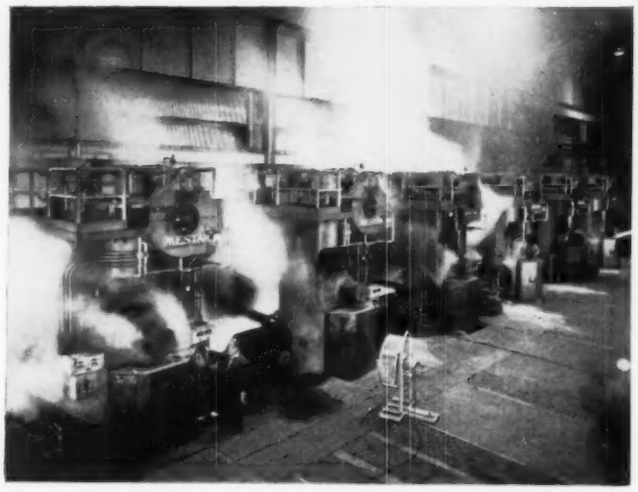


Figure 5 — Each of these finishing stands on the new 44-in. hot strip rolling mill is driven by a 3000-hp motor.

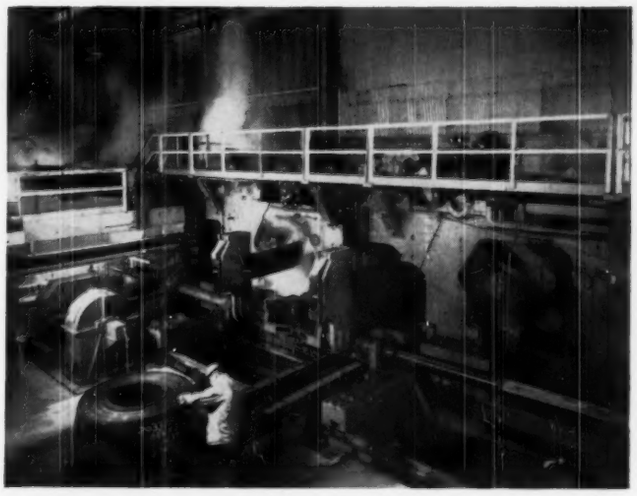


Figure 6 — The new 44-in. semi-continuous hot strip rolling mill has two downcoilers.

44-In. Mill at Aliquippa

permit the mill to operate independently of the blooming mill.

The building housing the mill is 936 ft long and 62 ft wide. Two additional bays contain the slab yard, motor room, and roll shop. All bays are serviced by overhead electric cranes. The building is covered with J & L's JalZinc, corrugated galvanized sheets produced at the Pittsburgh Works. General Electric Co. furnished the electrical equipment for the finishing end of the mill, and the electrical equipment was installed by the Howard P. Foley Co. The contractor for the foundation work was John F. Casey Co. Bethlehem Steel Co. furnished the structural steel for the building. Electric equipment for reversing rougher was furnished by Westinghouse Electric Corp. Mill was furnished and installed by Mesta Machine Co.

MILL OPERATION

The sequence of operation for the rolling of a slab to a coil follows this pattern:

A lift of slabs is deposited on the depiler at the entry end of the furnace in the proper rolling sequence. The depiler elevator is lowered and the top slab stripped on to the furnace charging table.

The furnace charging operator positions the slab in regard to the furnace skids and side walls by means of furnace charging tables. The slab is pushed onto the furnace entry skids by means of the furnace pusher and stopped when lead contact is made with the preceding slab.

When the slab call light is turned on by the reversing mill operator, the furnace charge is advanced to discharge the next slab. The pusher is then returned to the back position to repeat the cycle. The actual slab drop-out is observed by the

(*Please turn to page 169*)

"We cut Electrical Installation Costs and got better protection

. . . by installing Fusetron Fuses throughout our New Dairy Plant!"

William J. Oyala
ELECTRICAL SUPERVISOR
Fred Meyer Co. Portland, Oregon

Mr. Oyala continues . . .

"In our new dairy plant in Portland, Fusetron dual-element fuses saved us about $800 by enabling us to use the proper switch sizes for the motor disconnects. This was possible because the long time-lag of Fusetron fuses permitted us to install them in smaller sizes than would have been possible with ordinary fuses.

"In addition, we were able to reduce the space required by the control centers.

"The Fusetron fuses were installed in sizes small enough to give us motor-running protection as well as motor branch circuit protection.

"The result of this has been the prevention of motor burnouts. Not once in the past year of operation has a Fusetron fuse failed to protect a motor. We have 138 motors, ranging from 1/40 H.P. to 100 H.P., and all are protected by Fusetron fuses.

"Both Mr. Eric Christenson, whose company contracted the electrical work, and myself believe that by installing Fusetron fuses throughout our entire plant we got top protection at a cost lower than could have been obtained by any other method."

FUSETRON DUAL-ELEMENT FUSES PROVIDE SAFER, MORE DEPENDABLE PROTECTION

Only Fusetron fuses provide 10 point protection—not possible with any other type of protective device.

Thus, wherever a Fusetron fuse is installed you have safety as sure and dependable as you can buy—no matter what you pay.

AND FUSETRON FUSES REMAIN SAFE THROUGH THE YEARS . . . NO MAINTENANCE COSTS

Once properly installed Fusetron fuses are maintenance free. They require no costly inspection or downtime for calibration and other maintenance necessary on mechanically operated devices.

Dust, fumes, corrosion or age cannot prevent a Fusetron fuse from opening safely. There are no hinges, pivots or contacts to stick or slow down the operation of the fuse on short-circuit.

NO RECALIBRATION COSTS

When a Fusetron dual-element fuse does blow, there is no recalibration needed. As quickly as the fault in the circuit is corrected, you slip in a new fuse. The new Fusetron fuse is just as it came from the factory—accurately calibrated—and ready to give the same safe, dependable, coordinated protection as did the one it replaced.

FOR LOADS ABOVE 600 AMPS.—USE BUSS Hi-Cap FUSES to coordinate with FUSETRON Fuses.

On 600 volts or less, BUSS Hi-Cap fuses have an interrupting capacity sufficient to handle any fault current regardless of system growth.

They can be coordinated with Fusetron fuses on feeder and branch circuits to limit fault outage to circuits of origin.

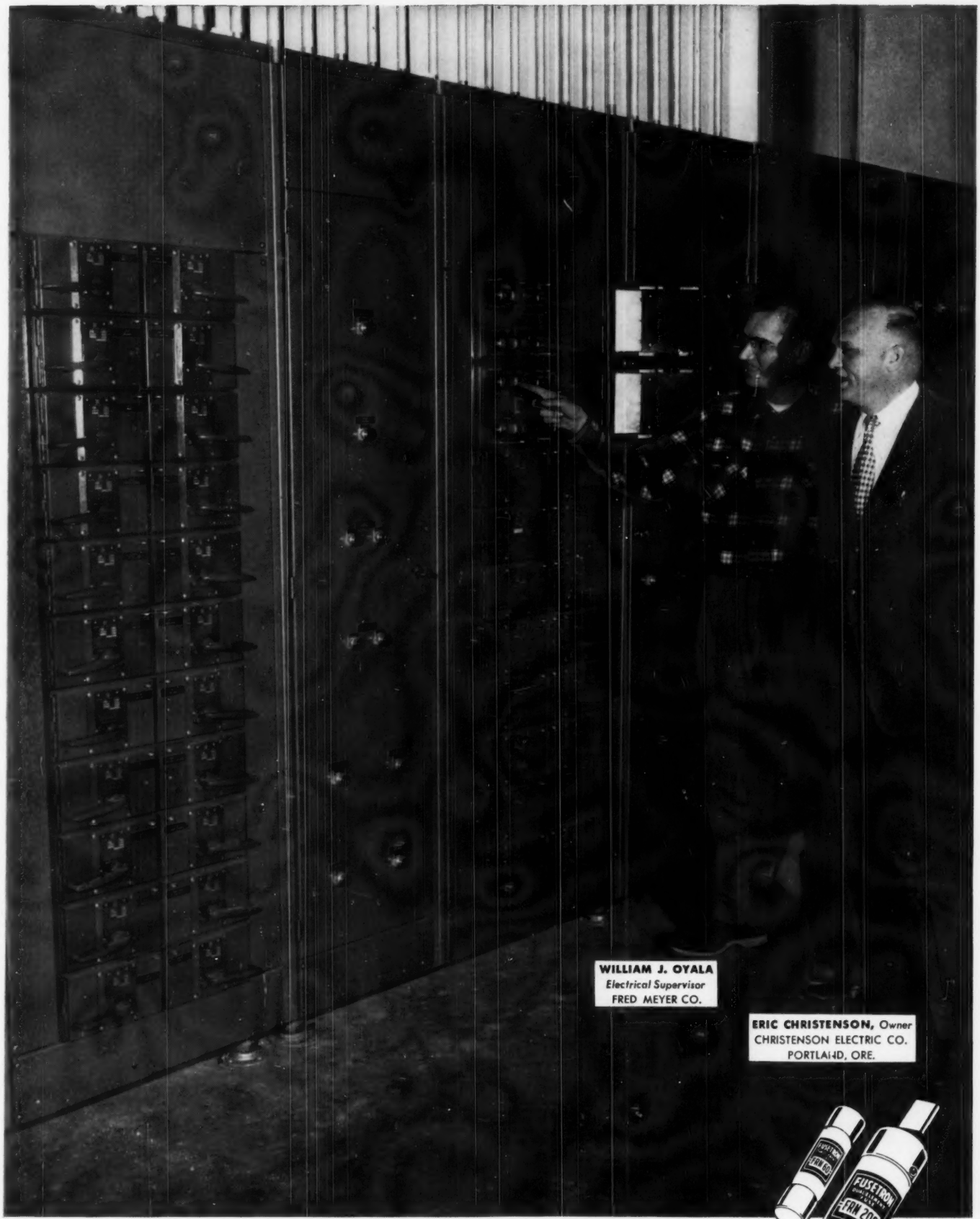
Write for bulletin HCS.

For more information on FUSETRON dual-element Fuses . . . Write for bulletin FIS.

BUSSMANN MFG. DIVISION *McGraw-Edison Co.*
University at Jefferson, St. Louis 7, Mo.

NATIONAL ELECTRICAL WEEK
FEB. 9-15, 1958

158



Play Safe! Install Fusetron dual-element fuses and BUSS Hi-Cap Fuses throughout entire Electrical System!

PROOF: Shaw-Box can build cranes to your specs (or AISE)

Every steel mill has its own special materials handling problems. Problems which could be handled by standard crane designs 30 years ago now demand cranes built to specifications unique to a single mill.

These ten leading steel companies developed their own crane specifications (or chose modern AISE standards.) Each awarded the job of constructing the crane to Shaw-Box.

REASON: Shaw-Box can produce *any* type of crane of *any* capacity. We are not bound by traditional concepts of design. Usually, we can offer better delivery. Control of Shaw-Box Cranes is a miracle of precision and speed.

When your company next prepares specifications for a crane — of any type — make sure they are sent to Shaw-Box.

58K-1

"Shaw-Box" CRANES

MANNING, MAXWELL & MOORE, INC.
SHAW-BOX CRANE & HOIST DIVISION
388 West Broadway • Muskegon, Michigan

Builders of "SHAW-BOX" and 'LOAD LIFTER' Cranes, 'BUDGIT' and 'LOAD LIFTER' Hoists and other lifting specialties. Other Divisions produce 'ASHCROFT' Gauges, 'HANCOCK' Valves, 'CONSOLIDATED' Safety and Relief Valves. 'AMERICAN' and 'AMERICAN-MICROSEN' Industrial Instruments.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Avenue Road, Galt, Ontario.*

(*Continued from page 165*)

charging operator on a closed circuit TV system. The reversing mill operator will then turn out the slab call light.

The discharged slab is advanced on the furnace delivery tables to the vertical edger approach tables by the reversing mill operator. From this point, the roughing operation is an automatic sequence controlled by Prodac. The complete rougher rolling sequence for each slab is initiated by a push-button.

As the slab passes through the vertical scalebreaking edger, a width reduction is made to break furnace scale and furnish the desired slab width. After the head end is delivered from this unit, the vertical edger descaling header is turned on for the purpose of removing this scale. Further scale removal is controlled by a header located on the delivery side of the reversing mill.

As the slab leaves the vertical scalebreaking edger, the edger and its approach table side guards remain open during the rolling cycle. During the rolling of the slab, the attached edgers maintain the width.

The slab or "breakdown" is delivered to the finishing stands where the head end is cropped, and its width and gage checked. The breakdown then enters the finishing scalebreaker, and then passes through two finishing scalebreaking descaling headers, one of which has taper spray control. It then enters six 4-high finishing stands, passes through width and thickness gages and along the runout tables. It then enters one of two mandrel-driven downcoilers. During this operation, entry, finishing and coil temperatures, along with width and thickness, are recorded. Three edgers have been installed on the finishing stands for width and edge control when rolling certain sections. These edgers are located before No. 1 stand, after No. 3 stand, and after No. 5 stand.

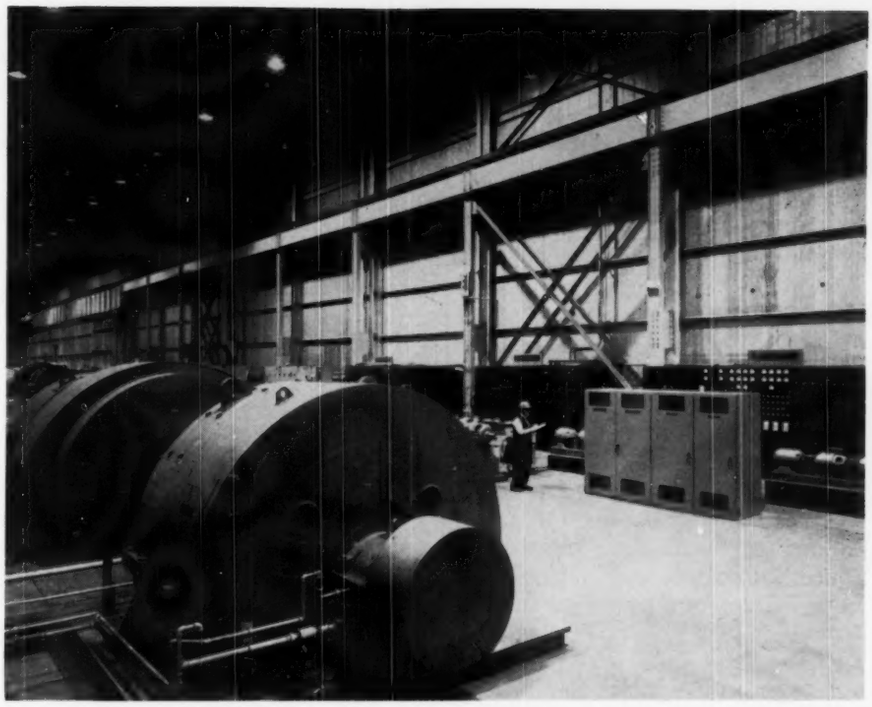


Figure 7 — A part of Prodac, the card reader, is located in the reversing rougher pulpit on the mill. The remainder of the unit, the memory and decision making equipment, is dwarfed by other equipment in the mill's motor room.

PRODAC

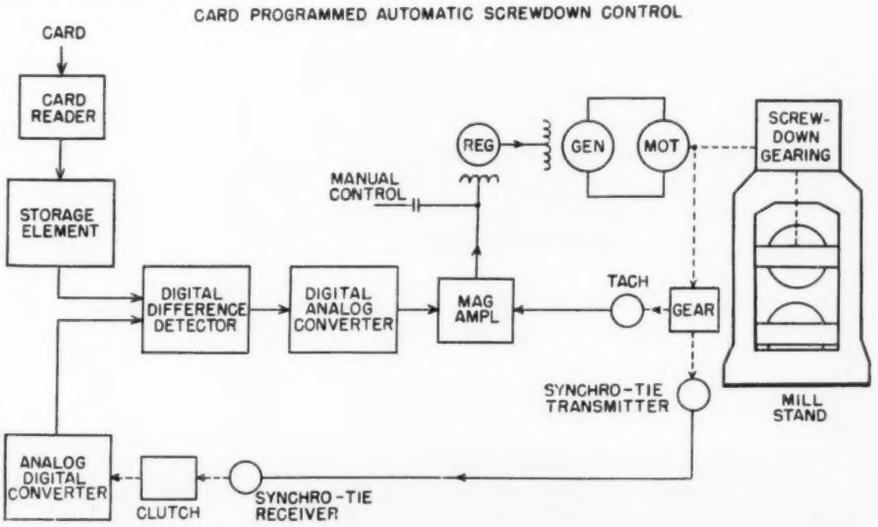
Completely automatic operation is possible. Under a new card-programmed system designed and built by Westinghouse, the mill operator can press a single button to initiate the complete rolling sequence for a given slab. Speed and roll openings of the edger and main rolls are predetermined for a complete schedule of up to nine passes by holes punched in a single punched card.

Prepared beforehand, IBM cards will be available for nearly every slab and strip size and for each grade of steel. These cards are prepunched to call for the optimum drafts and speeds that give uniform production at as high a production rate as possible.

A single IBM card includes all information required for a given schedule and controls: (1) mill screwdown opening, from 0 to 14 in. in $\frac{1}{32}$-in. increments; (2) edger adjustment opening, from 6 to 44 in. in $\frac{1}{16}$-in. increments; (3) mill speed, at 115, 300, 440, 715, 880, or 1100 fpm; and (4) edger speed, which is matched to mill speed, but from 0 to 60 per cent slower to take care of draft in the horizontal mill. Eight 7.5 per cent steps are available. Also included on each card is a notation to indicate the last pass.

To make mill operation completely automatic, a detector that

Figure 8 — Block diagram shows operation of card program automatic screwdown controls.



responds to strip radiation is located on each side of the mill. Each of these detectors is approximately 15 ft from the centerline of the mill and initiates the slowdown when the tail end of the strip approaches the mill. A load detector on the mill detects the instant the strip leaves the mill for fast repositioning of the rolls and re-entering for the next pass. Tests during initial operation show that slabs are kicked out only far enough to clear descaling sprays. Kickout distance varies in the order of two in. regardless of slab conditions.

In operating conventional manually controlled reversing mills, operators must call upon great experience, judgment, and alertness. In a single day, he may be responsible for rolling a number of schedules, each consisting of from five or more passes according to the product to be produced. For each of these passes, the operator must control mill speed, mill direction, and roll positioning. Further, for each schedule, he must control the various tables associated with the mill, guides for alining the material, and water sprays. If there is an edger, he must also control the setting of the edger rolls.

With many decisions to be made very rapidly, it is apparent that human error is possible, with consequent losses in production or product quality. A system which permits precise scheduled mill operation would obviously benefit both product quality and mill output.

If a sequence of slabs is to be processed identically, the operator needs only to press the pass advance button and full automatic operation for the second schedule will occur. If the second schedule is to be different, then pressing the schedule advance button will cause information from the second card in the reader to be extracted and the new schedule will be executed automatically when the pass advance button is pressed.

The system also provides for automatic control of scalebreaking edger and descaling sprays. Scalebreaking edger adjustment and scalebreaking edger side guards automatically close after the last pass of the schedule so that they will be in a proper position to make the scale breaking pass on the next slab and automatically open after the first pass of a schedule in order to be moved out of the way. Manual switches are still operative on these drives at any time required.

Scalebreaker edger descaling sprays are turned on automatically whenever steel is in the scalebreaker. Time delay relays adjustable between 0 and 3 seconds are incorporated to delay the turning on and turning off of the sprays to compensate for the distance between the scale breaking edger and the sprays. A switch is available on the operator's desk to select either manual or automatic operation of this set of sprays.

Descaling sprays on the delivery side of the mill are turned on automatically on all even passes and stay on as long as steel is in the mill. A switch is available on the operator's desk to select either manual or automatic operation of this set of sprays.

It can be seen that this system uses prescheduling to relieve the operator from the heavy responsibilities of manual control, thus permitting him to monitor the operation and to operate associated auxiliaries. Possibility of errors is further reduced since each card contains inherent digital checking information.

To illustrate signal process operations incorporated in Prodac controls, we see in Figure 8 a schematic diagram of the system for automatically controlling screwdown, the separation between upper and lower rolls. In this system, information applying to screwdown is transferred from punched card into storage by the IBM card reader. An analog signal representing actual roll separation is transmitted from the mill to an analog-to-digital converter for conversion into digital form. When the operator presses the pass advance button to initiate rolling operations, digital reference information for the desired roll separation is extracted from storage and supplied to the digital difference detector. At the same time, the signal corresponding to actual roll separation is passed to the digital difference detector. Here a subtraction operation yields a resultant signal representing the difference between the actual and desired roll separation. This signal is then processed by the digital-to-analog converter to yield an analog signal for input to a magnetic amplifier. When output of this magnetic amplifier is supplied to a rotating regulator, an adjustable voltage drive adjusts the screws until roll separation is equal to that originally specified by the punched card.

Similar processes for information storage and signal conversion, matching, and amplification are used to control mill speed, edger speed, and edger opening. ▲

NOW–ALLOY CHAIN REPAIR SERVICE

in PITTSBURGH and HAMMOND

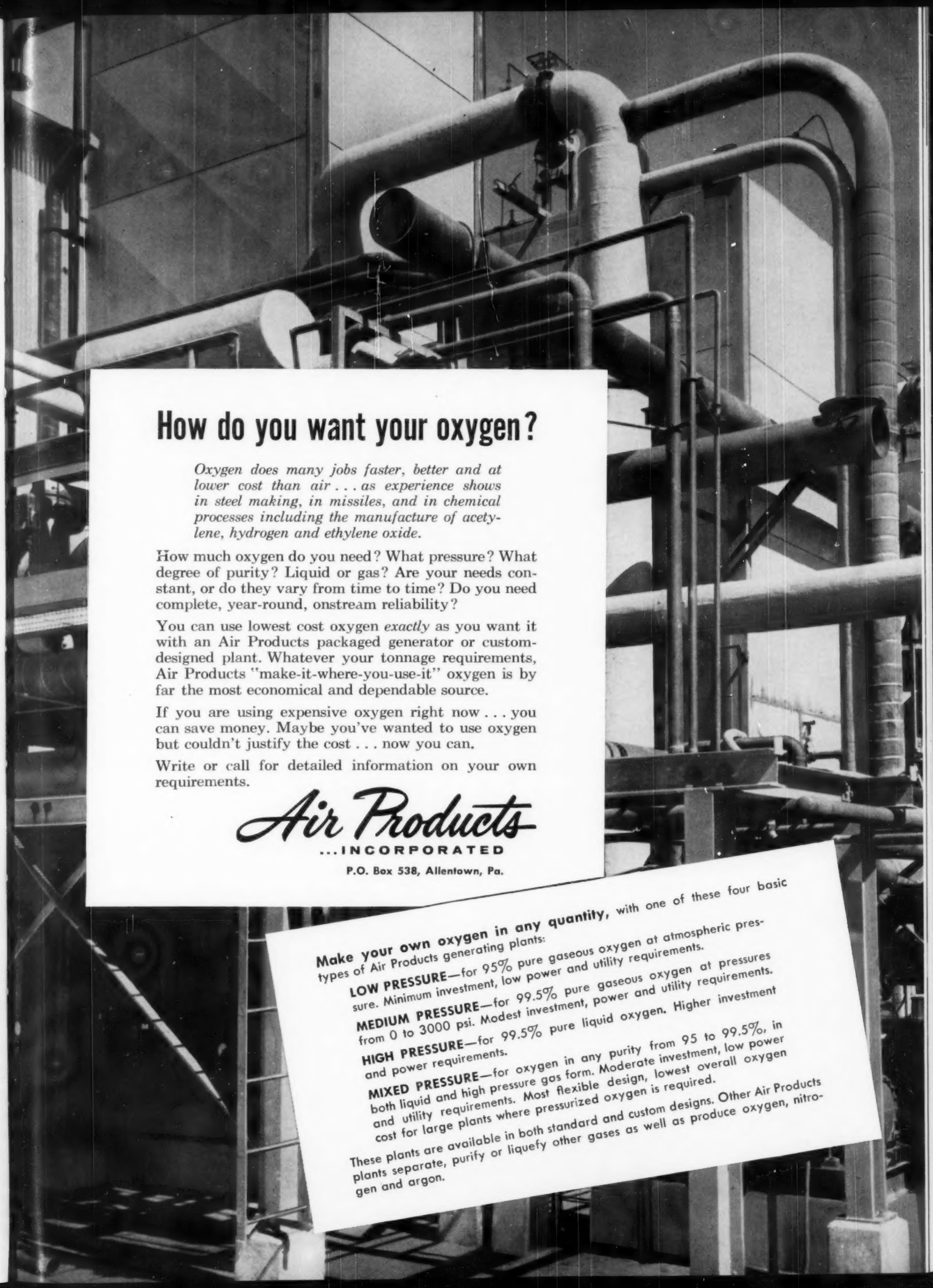
For greater safety and economy, have your Alloy Sling Chains returned to either our Pittsburgh or Hammond plant for repair, inspection and testing, at nominal cost.

S. G. TAYLOR CHAIN CO., Inc., Hammond, Ind.
and 3505 Smallman St., Pittsburgh 1, Pa.

Call or Write STAMCO for...

Corrugating and Complete Line of Culvert Equipment—Slitting and Coiling Equipment for Ferrous and Non-Ferrous Material in All Capacities—Warehouse and Steel Mill Cut to Length Lines for Shearing and Levelling Sheets from Coils—Shears for Shearing Sheets and Plates Both Underdriven and Overdriven Types in all Capacities up to 1¼" plate.

STAMCO, Inc., New Bremen, Ohio



How do you want your oxygen?

Oxygen does many jobs faster, better and at lower cost than air . . . as experience shows in steel making, in missiles, and in chemical processes including the manufacture of acetylene, hydrogen and ethylene oxide.

How much oxygen do you need? What pressure? What degree of purity? Liquid or gas? Are your needs constant, or do they vary from time to time? Do you need complete, year-round, onstream reliability?

You can use lowest cost oxygen *exactly* as you want it with an Air Products packaged generator or custom-designed plant. Whatever your tonnage requirements, Air Products "make-it-where-you-use-it" oxygen is by far the most economical and dependable source.

If you are using expensive oxygen right now . . . you can save money. Maybe you've wanted to use oxygen but couldn't justify the cost . . . now you can.

Write or call for detailed information on your own requirements.

Air Products
...INCORPORATED

P.O. Box 538, Allentown, Pa.

Make your own oxygen in any quantity, with one of these four basic types of Air Products generating plants:

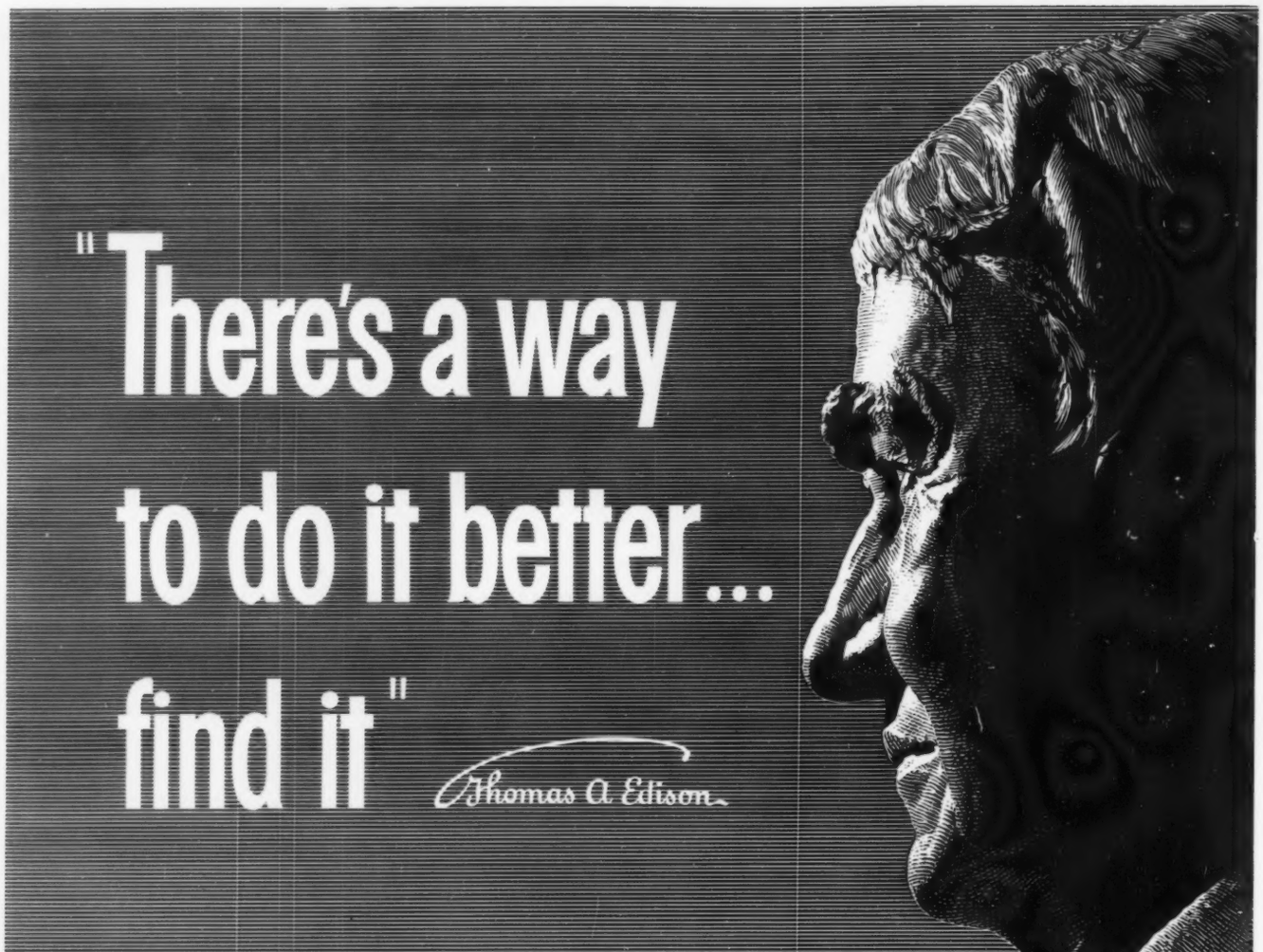
LOW PRESSURE—for 95% pure gaseous oxygen at atmospheric pressure. Minimum investment, low power and utility requirements.

MEDIUM PRESSURE—for 99.5% pure gaseous oxygen at pressures from 0 to 3000 psi. Modest investment, power and utility requirements.

HIGH PRESSURE—for 99.5% pure liquid oxygen. Higher investment and power requirements.

MIXED PRESSURE—for oxygen in any purity from 95 to 99.5%, in both liquid and high pressure gas form. Moderate investment, low power and utility requirements. Most flexible design, lowest overall oxygen cost for large plants where pressurized oxygen is required.

These plants are available in both standard and custom designs. Other Air Products plants separate, purify or liquefy other gases as well as produce oxygen, nitrogen and argon.



With those words, Thomas A. Edison, whose 111th birthday we celebrate on February 11th, set forth the principle that was to guide his inventive genius. Holder of more patents for basic inventions and improvements than any other man, Edison pioneered in harnessing the power of electricity for the benefit of mankind.

The electric age we now live in has gone far beyond even Edison's dreams. The force that he tamed has been expanded and developed until today it serves us all and contributes immeasurably to our whole standard of living. Thanks in large part to the vision and ingenuity of the Electric Light and Power Companies, "Housepower" today staffs most American homes with a minimum of nine electric servants. Industrial power gives every U. S. worker the equivalent energy of 279 assistants.

At McGraw-Edison, ever mindful of our great heritage, we strive continually to find a "better way." This constant search leads to the quality found in the literally thousands of products we make for the more efficient distribution and use of electricity.

PENNSYLVANIA TRANSFORMER DIVISION
McGraw-Edison Company
CANONSBURG, PENNSYLVANIA Greater Pittsburgh District

McGRAW EDISON

Truck of Special Design Used in Roll Changing

"CHOCK pulling," an operation necessary to the cold steel rolling industry, has recently undergone a change at United States Steel's Gary Sheet and Tin Mill located in Gary, Indiana. The chocks which house bearings at each end of huge work rolls weigh between 1500 and 2000 lb. The mill has 12 pairs of rolls working in 48 bearings which must be removed as the rolls show wear. There is an average of 36 bearings changed in an 8-hr turn.

Converting from an overhead crane function, the new method uses a fork lift truck designed especially for the job, by the Automatic Transportation Co. of Chicago.

The chief advantage in using a fork lift for the operation is the release of an important and busy overhead crane, which is needed to service grinders and blasters and setting up backup and work rolls.

Once worn rolls have been removed by the overhead crane and set in wooden cradles on the floor, the truck is run up to the roll's end and the industrial truck's forks raised underneath the coupling which is removed easily by backing the truck out. This holds true also in removing the chock—if it is not stuck.

When one is difficult or "sealed" the gripping arms on either side of the forks with which the Skylift is equipped is brought into play. They are placed on both sides of the truck and the push pull shoes are turned out to catch the chock in the rear. The truck's hydraulic pushing ram is then powered against the roll neck at the rate of 1500 psi and the chock is "pulled" free from the roll.

Removed chocks are either placed in storage or go right back on work rolls which have been turned and serviced. ▲

Figure 1 — The roll's coupling is easily slipped off the neck by closing the fork spread underneath it and placing the truck in reverse. This is the preliminary operation to removing the bearing chock.

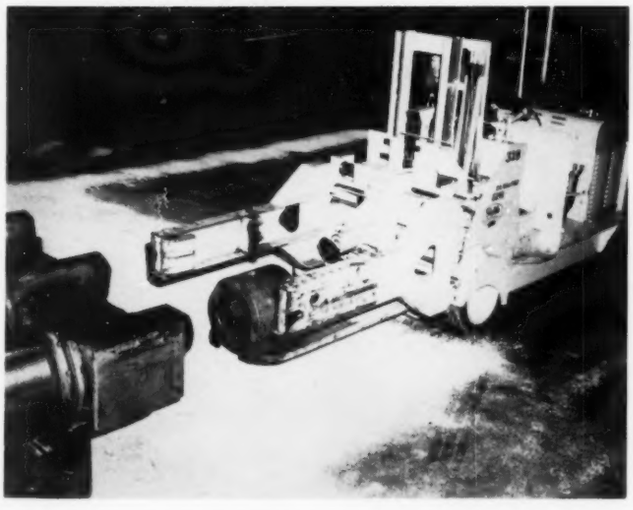
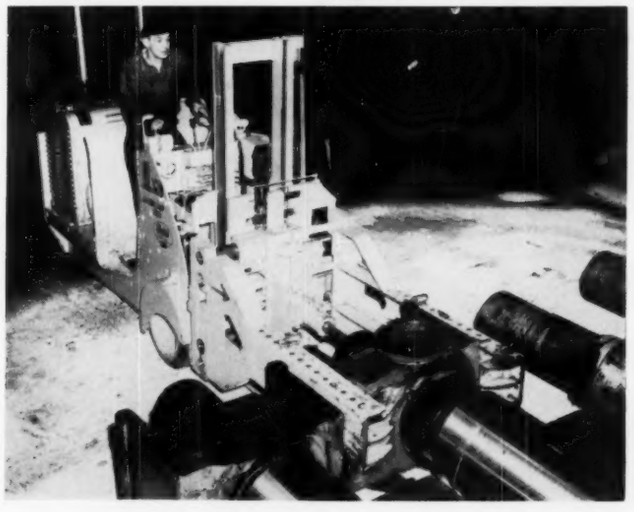


Figure 2 — With a pressure of 1500 psi, the industrial truck's ram pushes against the work roll's neck and the push pull shoes in back of the chock free it. The ram's pushing distance is 10 in.—enough to free it from the roll.



Split Wind Blowing increases furnace production

A SPLIT wind blowing system recently installed by Dravo Corp., Pittsburgh, on three blast furnaces at the Aliquippa Works of Jones & Laughlin Steel Corp., played a contributing role in the shattering of plant production records within six weeks of its startup.

Output by five Aliquippa furnaces in August—three on the newly installed split wind blowing system, and the other two on conventional vertical engine blowing—totaled 191,422 net tons. This tonnage breaks a record established in March, 1953, when 187,674 net tons were produced.

The new production record was credited chiefly to a hearth enlargement in June of No. 2 furnace from 21½ to 28½ ft, aided by employment of split wind blowing on furnaces No. 1, 2 and 3.

The installation provides increased air flow to the three furnaces, all now having the same hearth capacity, without any major changes in already existing air blowing equipment.

The system connects two 110,000-efm turboblowers and one 50,000-efm turboblower in parallel into a common header, boosting the air available to each of the three furnaces up to 90,000 efm. With the smaller blower base loaded, speed of the two larger blowers is controlled by the split wind instrumentation to meet the demands of the blast furnaces.

Prior to this installation, No. 1 and No. 3 furnaces were individually blown by the two 110,000-cfm turboblowers, and No. 2 was blown by the smaller unit and two vertical engines. Operating in this manner, the full capacity of the two large machines could not be used to advantage.

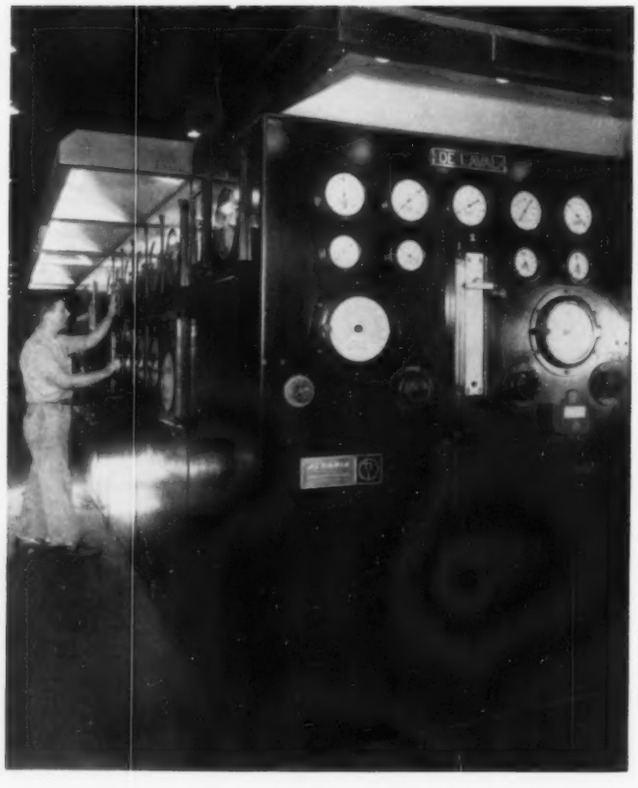
The split wind system is operated from a master regulator in the blow room and by remote control at each of the three furnaces. Built by the Askania Regulator Co., the equipment will maintain any desired preset header pressure between 5 and 30 psi gage.

The master control board in the blowing room is equipped with an audio-visual signal system which gives instant notice to the turboblower operator of any change in operating conditions at the blast furnaces.

For example, a red light signals that a furnace control valve is wide open and that header pressure should be raised; a green light indicates that a valve is too far closed and that header pressure should be lowered to save steam used by the turbines. A white light indicates that a furnace is on check or tap.

When any of the lights go on, a

Figure 1 (left)— Volume of air to be blown on a furnace is controlled at the furnace by the furnace blower. The instrument and control panel are linked with the master regulator system in the blow room and are enclosed in a small brick building on the furnace operating floor. Because of prevailing dirt and dust in the area, all air admitted to the control house is electrostatically cleaned. Figure 2 (right)— This master control system in the blow room at J&L's Aliquippa Works will maintain any desired preheat header pressure for blowing one, two or three blast furnaces. The board gives audio-visual signals of any change in operating conditions at the blast furnace.



SCHLOEMANN

five-Tube Tester

1. Singly movable heads
2. Jointly movable heads
3. Movable carriage
4. Charger and discharger
5. Prefill-water station
6. Pressure water station
7. Control desk

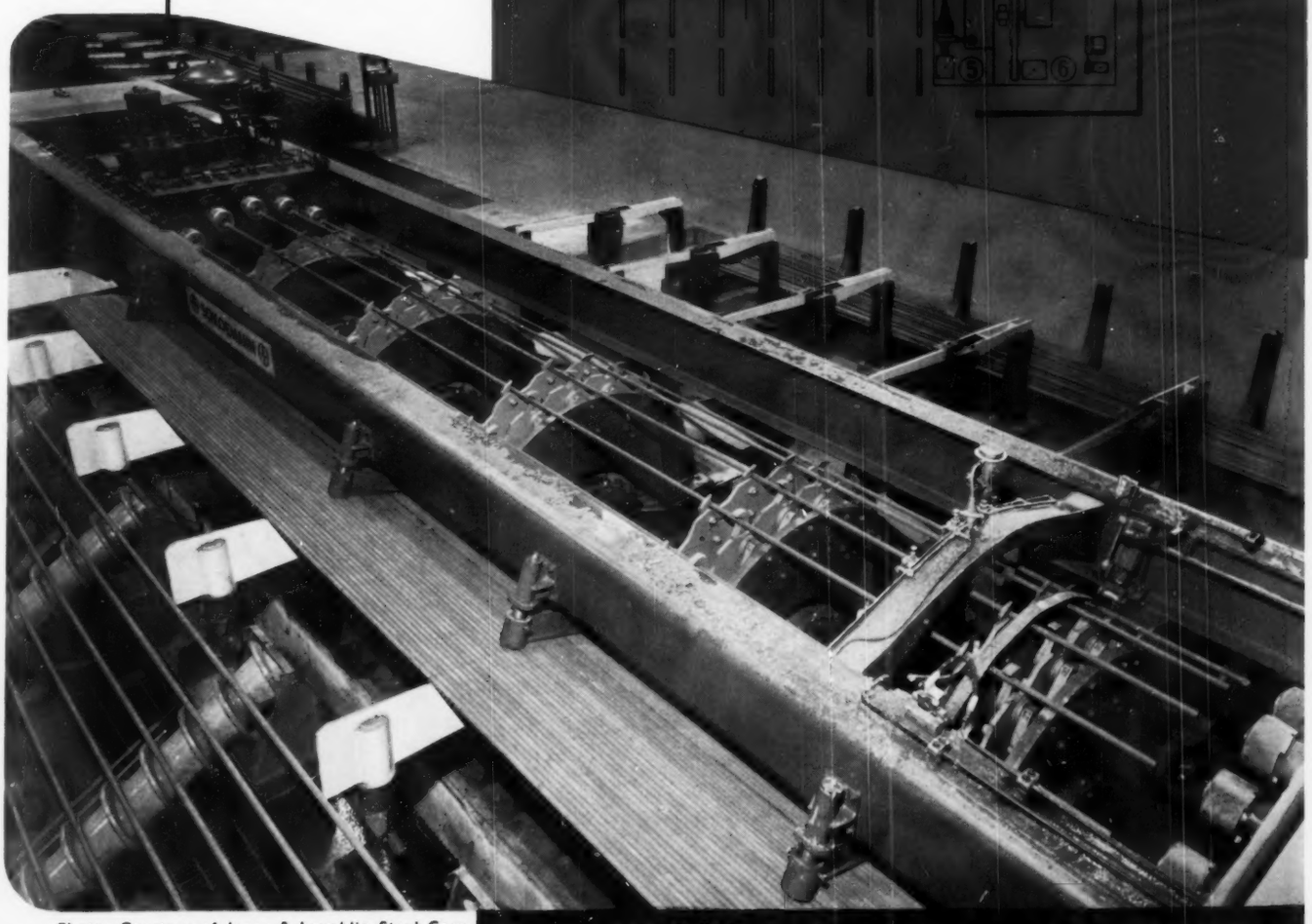


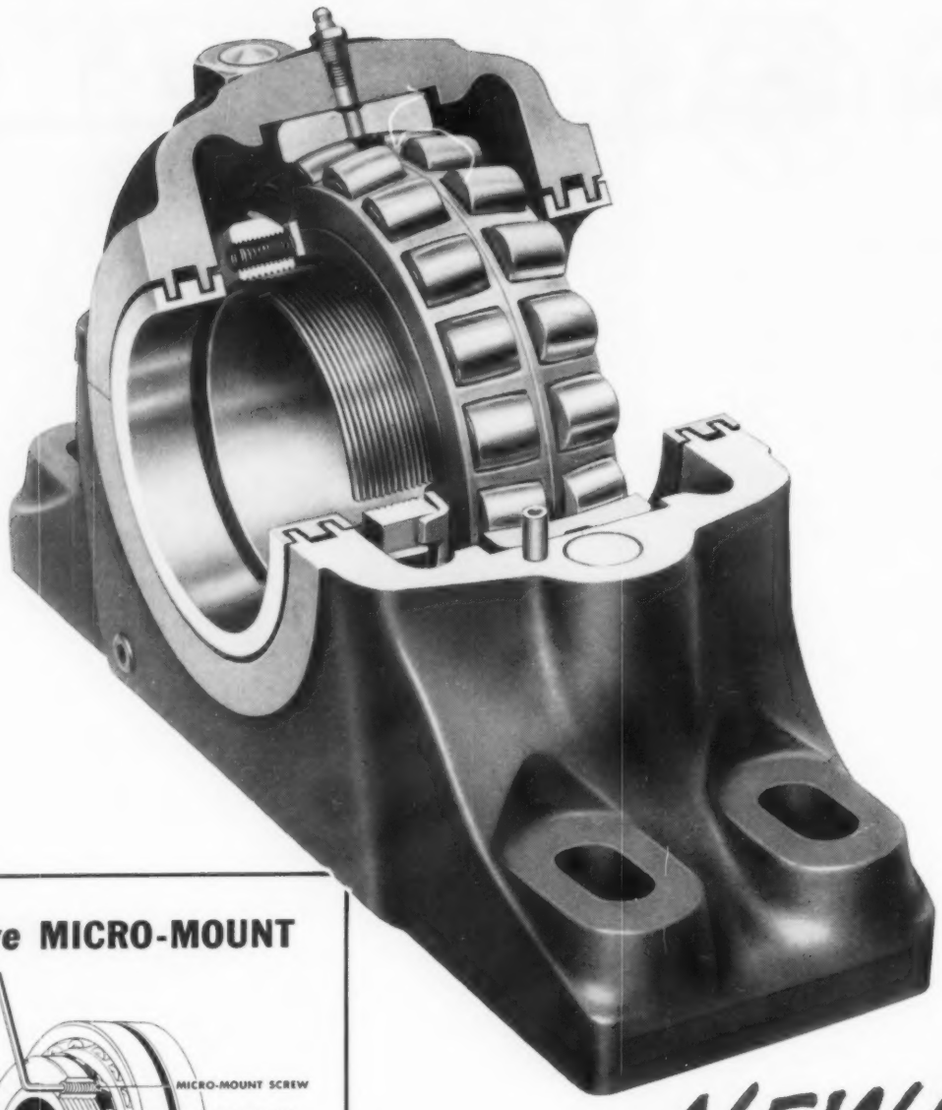
Photo: Courtesy of Jones & Laughlin Steel Corp.

Up to 1,200 tubes per hour • In operation in the U.S.A.

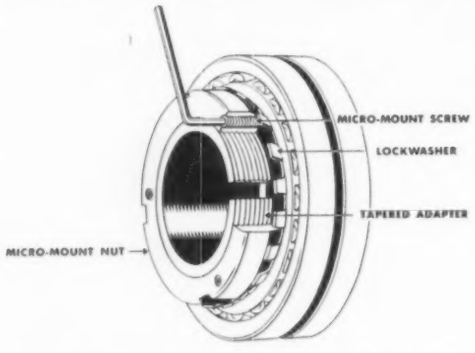
Tubes of varying lengths and diameters can be tested automatically on SCHLOEMANN's new five-tube tester. Two standard models are available – one for tubes ½ in. to 2 in. i. d., 17 ft. to 25 ft. long and another for tubes up to 4 in. i. d. and 50 ft. in length. Special design permits rapid change-over to different tube sizes. Maximum testing pressure 1,500 PSI (25 ft. model), 2,300 PSI (50 ft. model). – Electro-hydraulic pre-set controls. *For further details send for leaflet 3111e.*

FELLER ENGINEERING COMPANY 1161 Empire Building, Pittsburgh 22, Pa.

HOT AND COLD ROLLING MILLS • COUNTERBLOW HAMMERS • HYDRAULIC PRESSES



Exclusive MICRO-MOUNT



Fast and accurate mounting is made possible by the new Dodge Micro-Mount. The Adapter is snugged up with the Micro-Mount Nut. Mounting is completed by turning the Micro-Mount Screws against the Lockwasher until bearing, adapter and shaft form an integral unit.

NEW!

Spher-Align

SPHERICAL ROLLER BEARING PILLOW BLOCK

Dodge, the nation's leading supplier of mounted bearings, presents America's newest spherical roller bearing pillow block . . . a rugged bearing in attractive modern design . . . inherently self-aligning . . . easy to install . . . easy to maintain . . . and featuring the unique Micro-Mount.

Its rugged housing of close-grained semisteel withstands shock loads. It has a generous lubrication reservoir—for oil or grease. And standardized dimensions make Spher-Align interchangeable with all other similar units.

Expansion and non-expansion types. Stocked for 2 7/16" to 8" shafts. Call your Dodge Distributor—or write us.

DODGE MANUFACTURING CORPORATION
5900 Union Street, Mishawaka, Indiana

DODGE
of Mishawaka, Ind.

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable assistance on new methods. Look for his name under "Power Transmission Machinery" in the yellow pages of your classified telephone directory—or write us.

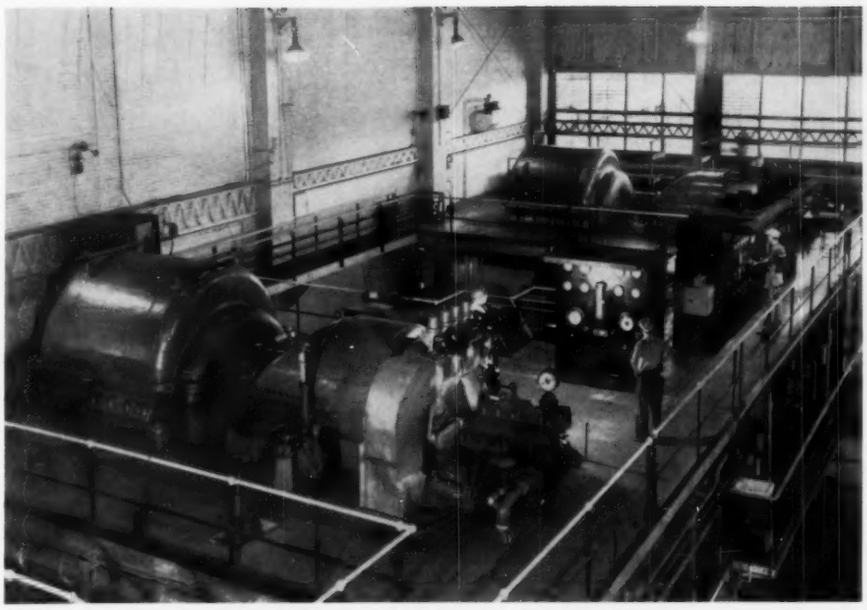


Figure 3 — The two 110,000-cfm turboblowers are tied into a common header with a base-loaded 50,000-cfm turboblower to blow three of the plant's five furnaces. Within six weeks of start-up of the system, the plant had shattered all previous tonnage records.

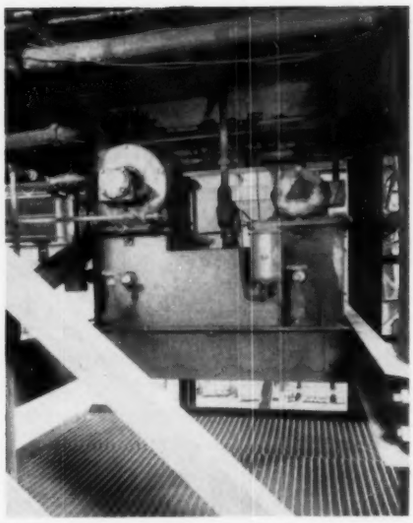


Figure 4 — Oil pressure for the split wind system at each furnace is supplied by a dual pump set. Should a motor-driven pump go out of service, a steam turbine pump automatically goes into operation.

horn will sound to alert the blower operator, and will continue to sound until a silencing button is pushed. The signal lights will remain on, however, until conditions at the signalling furnace have been brought back to normal. Direct communication also between the engine blowing room and each of the furnaces is maintained by a direct two-way telephone system.

Each of the two larger blowers is protected from surging by a minimum volume regulator on the master panel. This regulator bleeds sufficient wind to atmosphere to maintain stable conditions. While all controls are fully automatic, they can be operated manually if desired.

The entire instrumentation system is operated by hydraulics. Oil pressure in each local area is supplied by a dual oil pump set. Should a motor driven pump go out of service for any reason a steam turbine pump automatically will go into operation. An emergency hand operated pump on each furnace platform permits the opening or closing of control valves in event of complete failure of both pumps.

An open 8-in. by-pass line is installed around each of these furnace control valves to assure a minimum air flow under any set of circumstances.

In event of a furnace spill which would prevent the furnace operator from reaching his control panel, a remote control switch has been installed on the stove platform of each furnace. These switches enable the operator to shut the furnace down and bring the situation under control.

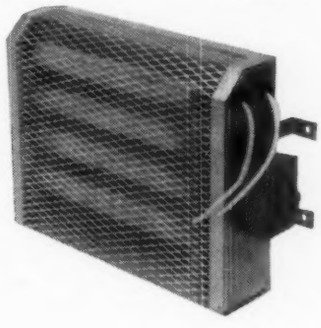
Volume of air to be blown on a furnace is controlled locally by the furnace blower and is set by a hand wheel on the furnace control panel. This panel is housed in a small brick building erected on the furnace operating floor. Due to the ever prevailing dirt and dust in this area, the instrument control house is windowless, and all air admitted is electrostatically cleaned. ▲

WALL TYPE

Guyan
HEATERS

FOR CONFINED AREAS

ALSO AVAILABLE IN FLOOR TYPE



RUGGED
and ECONOMICAL TOO!

WHEN the space is hard to heat — such as a crane or locomotive cab, a pump house or small office — a GUYAN natural convection heater is the answer. It is a DEPENDABLE, LONG-LIFE HEATER consisting of corrosion-resistant aluminum chromium wire — wound on ceramic forms — and mounted within expanded steel housings.

GUYAN Heater Units are ruggedly built to stand the hard service that is customary in tough industrial applications. Available from 1,500 thru 7,500 watts for 110, 220, 440 volts DC or AC. Priced right — more economically than you might think — and lower than you can make your own. Write for complete information.

GUYAN MACHINERY CO.
LOGAN, WEST VIRGINIA

Guyan
HEATERS

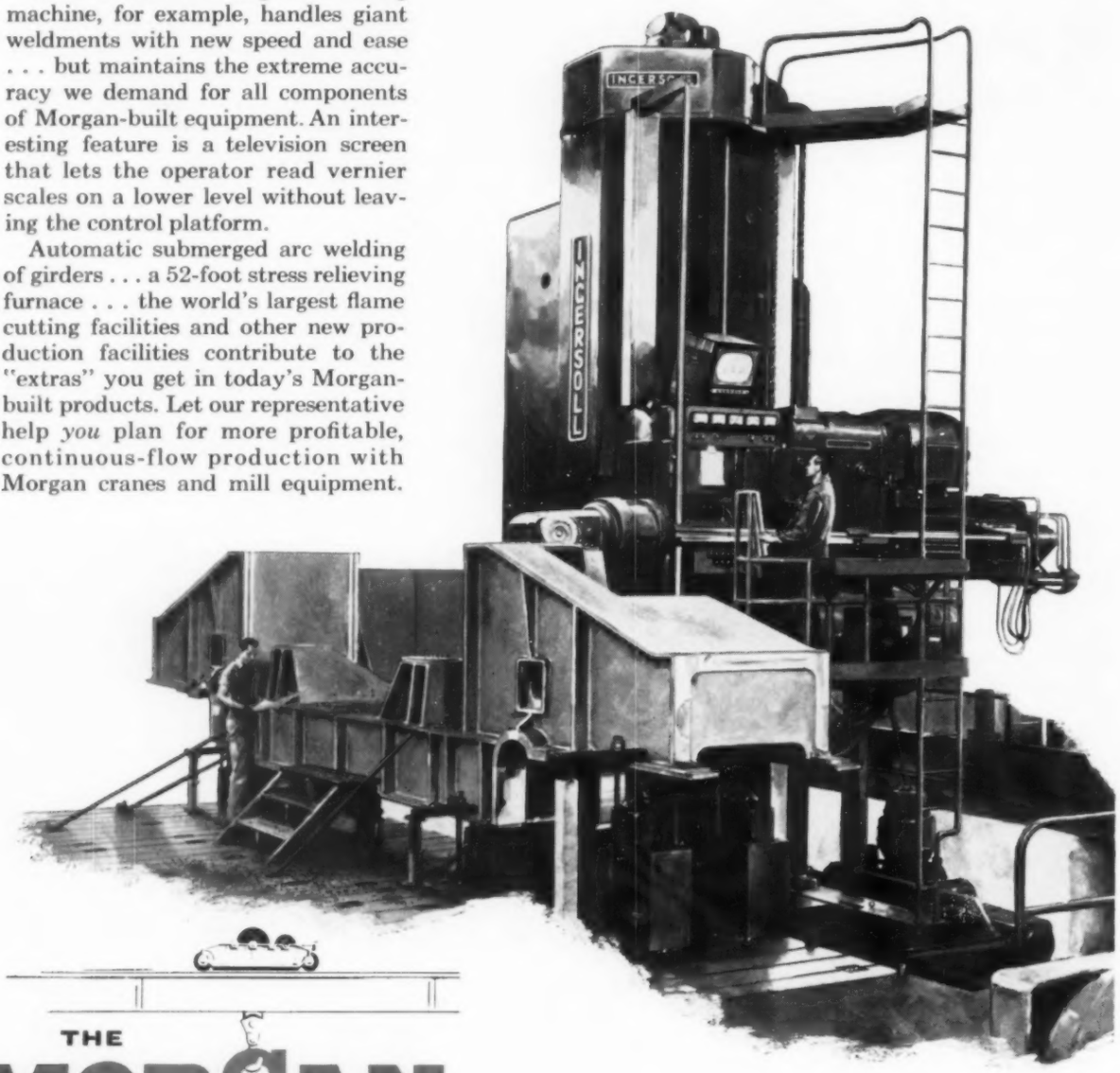
TV TAMES GIANT WELDMENTS

for Morgan Engineering cranes and mill equipment

New automation techniques put responsibility for precision manufacture of Morgan cranes and mill equipment in the hands of skilled technicians . . . plus exacting, efficient production facilities.

This 135-ton milling and boring machine, for example, handles giant weldments with new speed and ease . . . but maintains the extreme accuracy we demand for all components of Morgan-built equipment. An interesting feature is a television screen that lets the operator read vernier scales on a lower level without leaving the control platform.

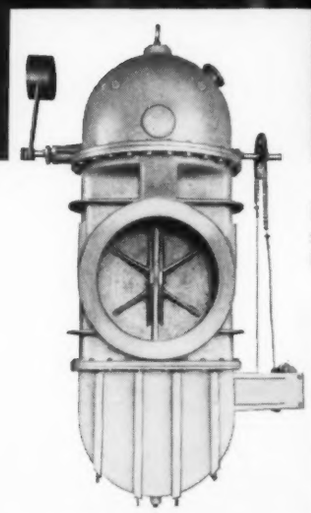
Automatic submerged arc welding of girders . . . a 52-foot stress relieving furnace . . . the world's largest flame cutting facilities and other new production facilities contribute to the "extras" you get in today's Morgan-built products. Let our representative help *you* plan for more profitable, continuous-flow production with Morgan cranes and mill equipment.



THE
MORGAN
ENGINEERING CO. *Alliance, Ohio*

Overhead electric traveling cranes, gantry cranes, open hearth special cranes, plate mills, blooming mills, structural mills, shears, saws and auxiliary equipment.

Freyn-Jansen Stove Valve



Freyn-Jansen Stove Valve reduces stove changing time, prevents gas leakage at the burner.

For over 25 years this stove valve has satisfied blast furnace operators in many countries. Here's why:

. . . reduces stove changing time

It replaces the conventional stove door providing quick, effortless action that saves time and work in opening and closing the burner inlet to the stove, regardless of burner opening size. A counterweighted valve operating shaft permits fast, easy operation either by manual lever, motor actuator or compressed air.

. . . prevents gas leakage

Permanently installed with bolted flanges between the burner discharge and the stove inlet, the Freyn-Jansen Valve prevents any gas leakage.

. . . provides tight, sure closure

It's designed so that cold blast pressure forces the valve against the seat, not away from it. In fact, the higher the pressure, the tighter the valve seats—makes it impossible for the disc to be blown off the stove.

. . . eliminates maintenance

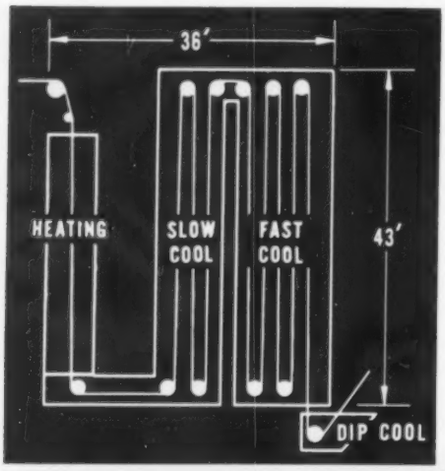
The conventional stove door requires maintenance of its refractory lining and gasket between the door and stove. Neither refractory lining nor gasket at the valve seat is used on the Freyn-Jansen Valve.

Send for descriptive information that gives you all the facts, or consult our engineers.

KOPPERS COMPANY, INC.
ENGINEERING AND CONSTRUCTION DIVISION
Pittsburgh 19, Pa.

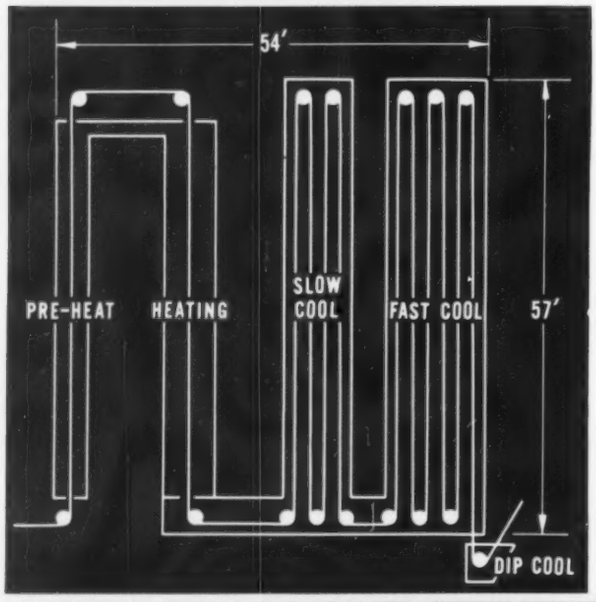
KOPPERS

FREYN DEPARTMENT
ENGINEERING AND CONSTRUCTION DIVISION



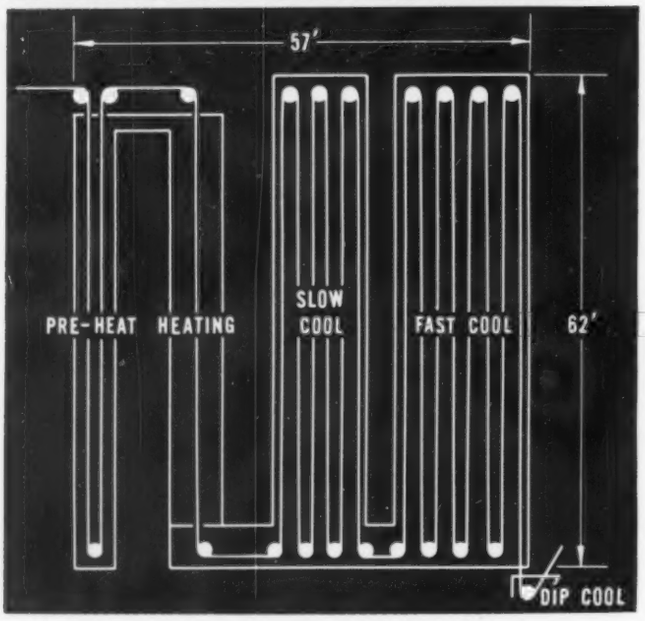
500 fpm

4 of these lines were installed across a standard mill building to provide an eastern steel producer with 400,000 tons per year increased capacity. The multiple installation enables this mill to meet simultaneously needs of several customers. Flow of material is across building because handling equipment, in relatively inexpensive lean-to-type structures, is installed at each end of line.



1,000 fpm

A midwestern steel producer preferred a single 1000-fpm line. Less than ⅓ longer than the 500-fpm line, the Selas line at left produces 200,000 tons per year of 44-in. strip.



1,500 fpm

Only 3 ft more length, 5 ft more height increases production 50%. Still compact, easy to install, simple to operate, economical to maintain. Even higher production rates can be attained with Selas direct-fired, single-pass strip annealing.

Continuous Strip Annealing by SELAS

...Simple
...Compact
...Practical

A glance at the diagrams shows the practical simplicity and compactness of the Selas single-pass, direct-fired heating principle.

The illustrations show how few rolls are involved, how little strip is in process. Notice that *no* rolls are in the heating sections.

Result: greatly-extended roll life, reduced maintenance costs, higher mechanical and electrical efficiency.

When strip stops, heating zone withdraws instantly, automatically . . . consequently accidental stoppages cause less down time and strip cannot be weakened by overheating.

Simplified construction means easier tracking, makes possible processing lighter gauges, wider strip.

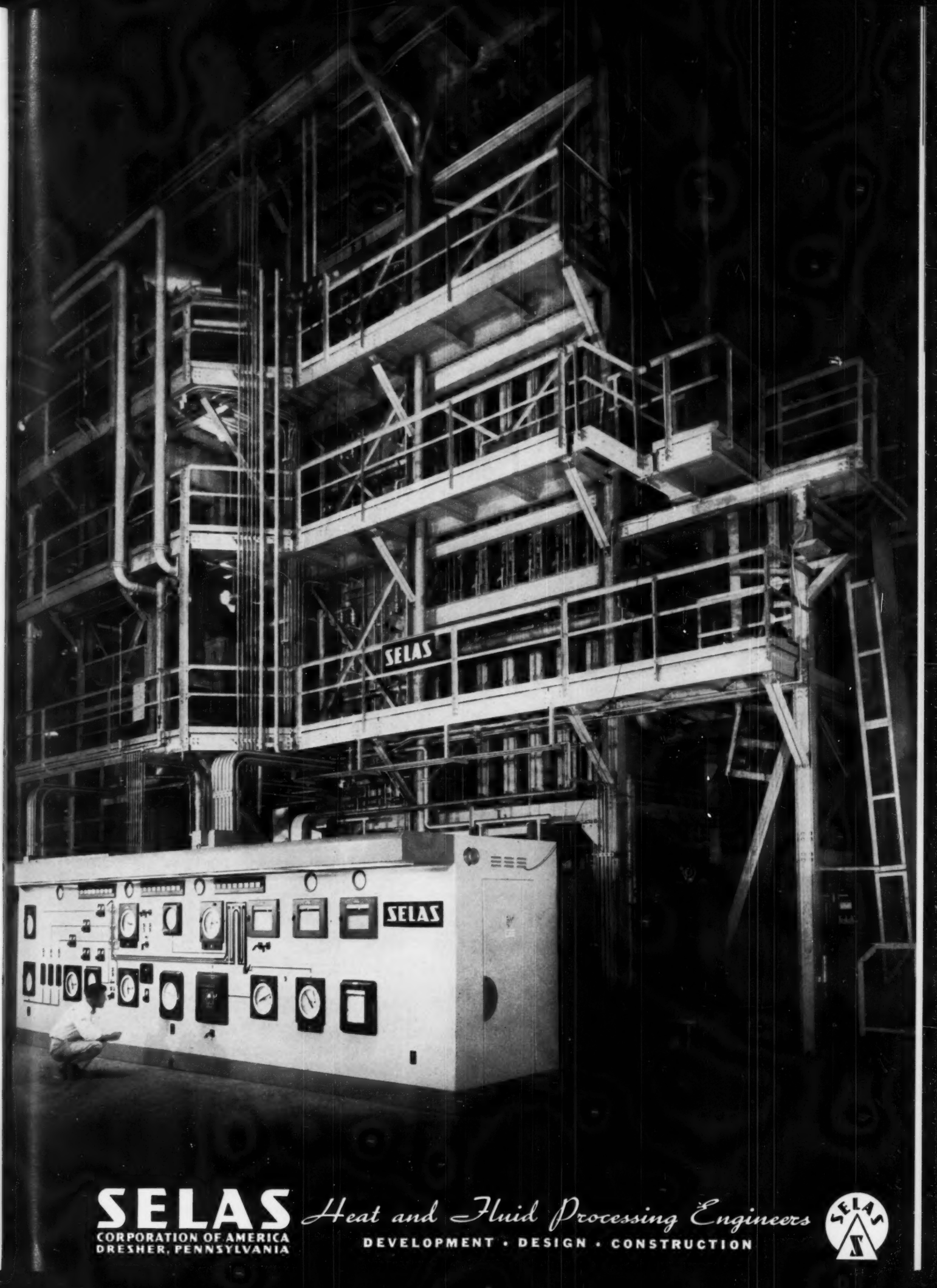
The compactness of the entire line keeps installation costs down, saves valuable floor space, in most cases permits installation in standard 100-ft mill buildings.

Selas continuous strip annealing lines—single or multiple installations—are designed and constructed to meet your production requirements for prime strip, in feet per minute or tons per hour. If and when these requirements change because of market demands, your Selas lines, with versatility built into them, will help you meet new conditions quickly.

Our engineers will be glad to discuss how this Selas concept of Gradiation® annealing can be tailored to your strip processing needs. Address Dept. 42, Selas Corporation of America, Dresher, Pa.

Gradiation is a registered trade name of Selas Corporation of America.

Compact Selas Control Cubicle saves valuable floor space and permits easy access to instruments. Graphic front panel functionally delineates process and control system of this continuous annealing line. It presents operating information more accurately, pictorializes process conditions and functioning of the production line. Flow diagram shows strip passing through Selas single-pass vertical furnace (located at center of panel), through controlled-cooling section (at right). Gas combustion control and temperature, strip speed, atmosphere composition indicators are related to diagram at points of operation. Heat input is controlled by integrating strip speed, fuel input and strip temperature measurements.

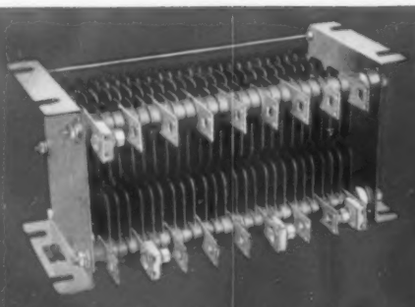


SELAS
CORPORATION OF AMERICA
DRESHER, PENNSYLVANIA

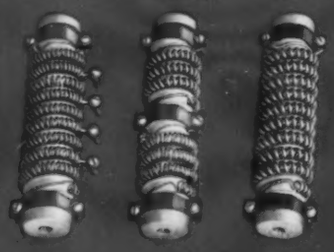
Heat and Fluid Processing Engineers

DEVELOPMENT • DESIGN • CONSTRUCTION

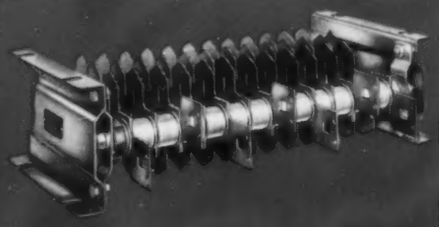
When you need MILL DUTY RESISTORS
insist on the finest...
insist on Cutler-Hammer



CAST GRID RESISTORS
Cutler-Hammer Bulletin 11010 Cast Grid Resistors are built to take it. Their extra rugged construction makes them ideal for those tough applications where severe overloads are to be expected. The individual cast grids are supported at three points within the sturdy steel frame and thoroughly insulated with mica tubes and washers. All grid terminals are easily accessible.

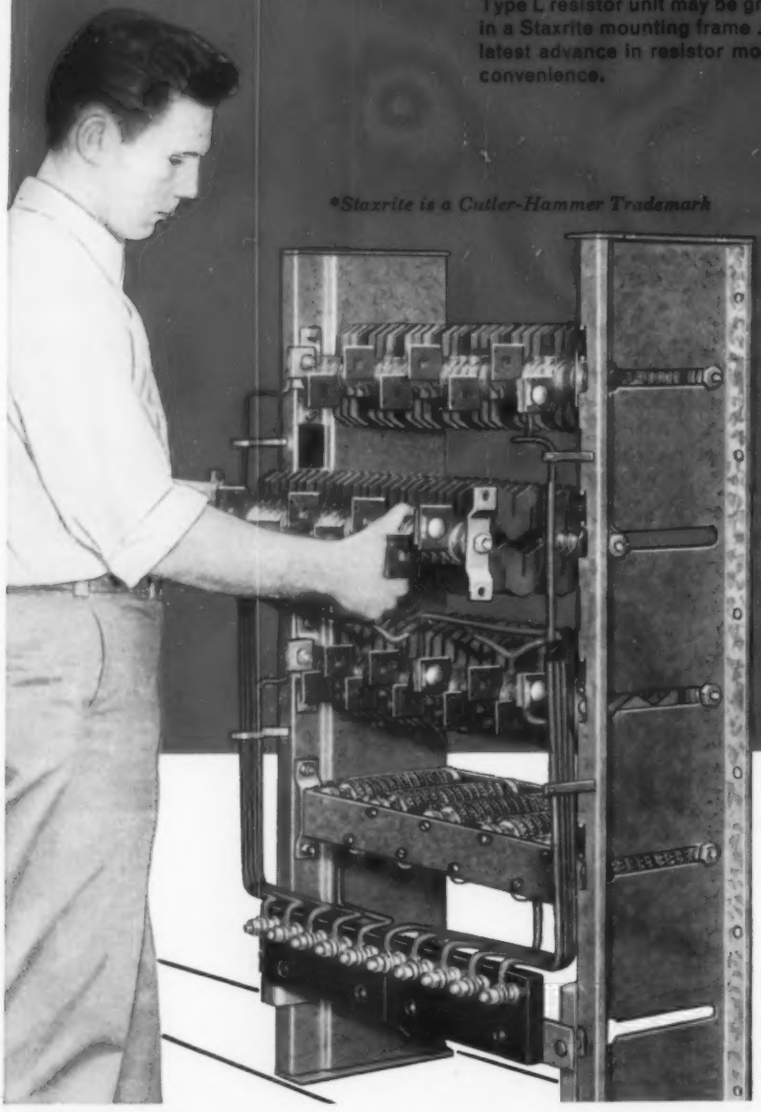


UNIT TYPE RESISTORS
These Bulletin 11003 Type L Resistors are available in a wide range of resistance values and capacities for either A-c or D-c service . . . perfect for scores of applications requiring a light weight, compact resistor element. Cutler-Hammer Type L resistors may be mounted separately or grouped in any of four standard size resistor frames. Note, multiple Type L resistor unit may be grouped in a Staxrite mounting frame . . . the latest advance in resistor mounting convenience.



NON-BREAKABLE RESISTORS
Cutler-Hammer's Bulletin 11011 Non-breakable Resistor with exclusive "draw-out" design is the choice among mill engineers everywhere. Grids are stamped from a chromium steel alloy and then welded together forming a continuous current path with a stabilized resistance value. These resistors are shock-proof, vibration-proof, and corrosion-resistant. Their high thermal capacity makes them ideal for severe mill and crane applications. And the "draw-out" design is extra value at no extra cost. All units slide in and out easily and quickly without disturbing the end frames, adjacent resistor units, or mounting members. "Draw-out" design will save you time and expense during installation, maintenance, and alterations.

*Staxrite is a Cutler-Hammer Trademark



Staxrite*—Here is the most modern and efficient means of mounting multiple resistor units . . . a Cutler-Hammer "first", a Cutler-Hammer exclusive. These units are free-standing and only require the floor area of a single resistor box, but they can accommodate up to nine resistor frames in a single unit. The Staxrite mounting frame packs more resistor material in a given space than ever before, and yet every resistor unit is easily reached and serviced because of the "draw-out" design. Complete terminal board wired assemblies practically eliminate costly on-the-job wiring. Unwired assemblies also available. The Staxrite mounting frame will handle the Type L resistor frame, the non-breakable resistor frame or a combination of both. Save time, save space, save money with Staxrite.

CUTLER-HAMMER
MOTOR CONTROL
C-H

Write today for further data on mill duty resistors and the Staxrite mounting frame. CUTLER-HAMMER Inc., 1269 St. Paul Avenue, Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto.

Date-line Diary...

January 3

Δ Defense Secretary McElroy estimated a rise in military spending to about $40,000,000,000, an increase of $1,500,000,000 over indicated outlays for fiscal 1958. The bulk of the increased expenditures will go into accelerated missile development.

Δ Auto production in 1957 reached 6,100,000 cars, an increase of 5.4 per cent over 1956; General Motors' share in 1957 was 46 per cent of the industry's total compared with 52.7 per cent in 1956; Ford's share of 30.9 per cent compares with 28.7 per cent in 1956; and Chrysler Corp.'s 19.98 per cent compared with 15 per cent in the previous year.

Δ The Aluminum Assn. reported that shipments of aluminum sheet and plate in November, 1957 totaled 81,089,000 lb, compared with 105,254,000 lb in October, 1957; shipments of aluminum foil in November, 1957 amounted to 15,387,943 lb; in October, 1957 shipments were 17,765,651 lb.

January 6

Δ The AISI reports that the operating rate of the steel industry for the week of January 6 is scheduled at 57.2 per cent of 1958 capacity. This is equivalent to 1,548,000 tons compared with 1,501,000 tons one week ago and 2,519,000 tons one year ago.

January 7

Δ Effective January 1, production and maintenance employees of the Weirton Steel Co., Div. of National Steel Corp., received an increase of five cents an hour, as a result of the cost-of-living escalator clause in the three-year contract signed by the company and Independent Steelworkers Union, July, 1, 1956.

Δ Steel production capacity of the industry as a whole at the start of 1958 totaled 140,742,570 net ingot tons, compared with official computed capacity of 133,459,150 tons in 1957.

Δ The Labor Dept. reported new claims for unemployment for the week of December 28, 1957 rose to 550,995, an increase of 137,400 over the previous week's new claims; in the like 1956 period, claims rose 50,000 to a total of 338,970.

Δ David J. McDonald indicated that the United Steekworkers may seek extra three-month vacations every five years when new contract talks begin in 1959, claiming the plan would not cost as much as the four-day week. David J. McDonald also urged the government to embark immediately on a public works program to offset an economic downturn.

Δ Shipments of iron and steel castings during October, 1957 amounted to 1,323,618 short tons compared with 1,191,598 short tons in September, 1957 and 1,531,892 short tons in October, 1956.

Δ The Bureau of Mines reports that estimated production of Pennsylvania anthracite for December, 1957 equals 1,836,000 net tons, compared with 1,938,000 tons in November, 1957 and 2,342,000 in December, 1956. Production for the year, 1957 totaled 25,472,000 net tons, for 1956 28,900,000 net tons.

January 8

Δ President Eisenhower asked $1,260,000,000 of new funds and $110,000,000 transfer of already appropriated money to the expansion of the missile program and related defense project to counter Russian scientific and military advances.

January 9

Δ Retail sales of U. S. built cars in 1957 eased to 5,847,000 units, down 5000 from 1956. Year-end stocks in dealers hands were 200,000 higher than at the close of 1956.

Δ The Commerce and Labor Depts. reported that construction outlays in 1957 were about $47,300,000,000, a 3 per cent increase of 1956.

Δ Copper price by custom smelters was down ½¢, to 25¢ a lb; spot copper in London fell ⅜¢ to 21⅞¢ a lb.

Δ The AISI reports estimated payroll for the iron and steel industry for November, 1957 amounted to $316,263,000 compared with $345,580,000 in October, 1957. Estimated total employment was 625,700 compared with 640,300 in October. Average hourly payroll cost per wage earner was $3.013 plus 29¢ fringe, compared with October cost of $2.992. Average hours worked a week was 36.1 compared with 38.0 in October. The estimated payroll for the first eleven months of 1957 is a record $3,703,800,000.

January 10

Δ The AISI reports that the operating rate of the steel industry for the week of January 13 is scheduled at 56.9 per cent of capacity. This is equivalent to 1,538,000 tons compared with 1,515,000 tons one week ago and 2,467,000 tons one year ago. Index of production for the week is 95.7.

Δ President Eisenhower sent Congress a $73,900,000,000 budget for fiscal 1959. For the year starting July 1, the President estimated revenues at $74,400,000,000, resulting in a $500,000,000 surplus, based on his forecasts that "the expansion of our economy will soon be resumed." For the current fiscal year, ending June 30, increased defense spending and reduction in revenues, a deficit of $400,000,000 is predicted.

Δ Prices in copper further declined. Producers dropped prices to 25¢, custom smelter charge fell ½¢ to 24½¢, and spot copper in London declined to 21.68¢ per lb.

Δ Avery C. Adams, president of J & L Steel Corp. forecast that steel prices will rise another $7.00 a ton at mid-year when wage increases are due under the three-year contract between steel producers and the USW.

January 14

Δ Court denies summary judgment in Bethlehem, Youngstown merger, citing need for clarification of section of Clayton Act. Trial is set for April 7 in Federal District Court, New York.

January 15

Δ The Labor and Commerce Depts. reported that unemployment in mid-December rose to 3,374,000, an increase of nearly 200,000 over the mid-November level. Total number of jobholders was 64,396,000, down 477,000 from mid-November.

January 16

Δ Federal Reserve Board announced margin requirements on stock purchases and short sales were reduced from 70 to 50 per cent effective today.

Δ The House Ways and Means Committee listened to recommended tax law changes, to provide a new depreciation formula designed to take into account the drop in the purchasing power of the dollar. This

would permit concerns reinvesting in new capital assets to get larger tax deductions on the facilities being retired.

Δ Howard R. Berlin, vice president of Johns-Manville Corp. predicted that construction outlays in the nation, in 1958 would be $66,700,000,000, including $22,000,000,000 of modernization and repair work, an estimate $500,000,000 above 1957 total.

January 17

Δ Loadings of rail freight for the week of January 11 dropped to 569,444 cars, down 16.4 per cent from the like 1957 period.

January 20

Δ The Bureau of Mines reported that the consumption of scrap during November, 1957 totaled 4,799,000 gross tons, pig iron used was 5,041,000 gross tons compared with 5,333,767 tons of scrap and 5,669,624 tons of pig iron in October, 1957.

Δ The AISI reports that the operating rate of the steel industry for the week of January 20 is scheduled at 55.8 per cent of capacity. This is equivalent to 1,500,000 tons compared with 1,538,000 tons one week ago and 2,472,000 tons one year ago. Index of production for the week is 93.4.

Δ The Bureau of Mines, U. S. Dept. of the Interior, reported that production of iron ore in the United States for October, 1957 totaled 11,337,283 long tons, shipments 12,833,938 long tons.

Δ Industrial Heating Equipment Assn. reports that new orders for industrial furnaces in December, 1957 were $3,992,000, compared with $5,848,000 in December, 1956; orders for induction and dielectric heating equipment in December were $573,000 compared with $1,093,000 in December, 1956. Totals for 1957, are industrial heating furnaces $55,005,000 compared with $79,357,000 in 1956; induction and dielectric heating equipment in 1957 totaled $11,069,000, in 1956 $14,840,000.

January 22

Δ Federal Reserve Board cut discount rate of the Federal Reserve Bank of Philadelphia from 3 to 2¾ per cent, effective today; Chase Manhattan Bank reduced the prime rate, on which all interest charges imposed on business borrowers are based, from 4½ to 4 per cent.

January 23

Δ The ARCI reports that deliveries of new domestic freight cars in December, 1957 totaled 6174 compared with 7142 in November, 1957 and 7260 in December, 1956. Orders totaled 3492 compared with 1070 for November, 1957 and 4923 in December, 1956. Backlog of cars on order as of January 1 stood at 55,941 cars compared with 59,194 a month earlier, and 117,257 on January 1, 1957. Total orders for 1957 were 42,051, in 1956 39,994; deliveries in 1957 amounted to 99,290 compared with 67,080 in 1956.

Δ The Agriculture Dept. reported that farm income for 1957 will total about $11,900,000,000 compared with $12,100,000,000 in 1956, attributing the decline to the bad turn out of the cotton crop.

Δ A. M. Byers Co. reported sales of $4,856,000 and gross manufacturing earnings of $718,000 for the fiscal quarter ended December 31, 1957.

January 24

Δ National Machine Tool Builders Assn. reported that orders in December, 1957 amounted to $18,600,000 down 34 per cent from November, 1957 and 65 per cent from December, 1956.

January 27

Δ The AISI reports that the operating rate of the steel industry for the week of January 27 is scheduled at 55.0 per cent of capacity. This is equivalent to 1,479,000 tons compared with 1,496,000 tons one week ago and 2,498,000 tons one year ago. Index of production for the week is 92.1.

January 28

Δ Spot copper strengthened in London to 20.81¢ a lb, up ¾¢ from last week's close.

Δ The Commerce Dept. estimated that national income in the final quarter of 1957 dropped more than $4,000,000,000 from the third quarter annual rate of $326,000,000,000; total income for 1957 is indicated below $358,500,000,000 though this is approximately $14,900,000,000 higher than 1956 income.

Δ Preliminary reports by August Thyssen-Huette indicate the 1956–57 fiscal year which ended September 30, sales at $204,400,000 compared with $172,000,000 in the previous year; crude steel production rose to 1,800,000 tons, 240,000 tons over last year. Present capacity is 2,400,000 tons up by the addition of four 250-ton open hearth furnaces since the fiscal year end.

January 29

Δ F. W. Dodge Corp. reports that December, 1957 construction contracts totaled $1,984,342,000, four per cent below December, 1956. Construction contracts in 1957 totaled $32,173,412,000, two per cent above the 1956 total.

January 30

Δ The Aluminum Assn. reported that shipments of aluminum sheet and plate in December, 1957 totaled 75,962,000 lb, compared with 81,084,000 in November, 1957; shipments of aluminum foil in December, 1957 amounted to 15,438,262 lb, in November, 1957 15,387,943 lb. Total shipments for 1957, sheet and plate 1,245,335,000 lb; foil 180,721,243 lb.

Δ AISC reported that shipments of fabricated structural steel for December, 1957 were 278,178 tons compared with 293,369 tons in November, 1957 and 297,785 tons in December, 1956. Bookings for December, 1957 amounted to 126,979 tons compared with 187,653 in November, 1957, and 404,429 tons in December, 1956. Backlog on December 31 equaled 2,395,099 tons, a decrease of seven per cent from November, 1957. Total shipments for the year 1957 were 3,651,973 compared with 3,205,488 tons in 1956; total bookings, in 1957 2,780,645 tons compared with 4,013,186 tons in 1956.

Δ United Engineering and Foundry Co. reports sales in 1957 totaled $100,456,069, net income was $5,069,960 equal to $2.02 per common share; in 1956 sales totaled $62,696,397, income $3,219,712 or $1.28 per common share.

January 31

Δ Shipments of iron and steel castings during November, 1957 amounted to 1,135,157 short tons compared with 1,323,618 short tons in October, 1957 and 1,422,403 short tons in November, 1956.

Δ J & L Steel will close its Cleveland works for ten weeks to install roughing mill, affecting output for a total of 18 weeks.

Δ Westinghouse Electric Corp. reported for the fourth quarter of 1957, sales of $531,770,000, net income of $23,550,000 or $1.36 a share, compared with net income of $4,891,000 or 26¢ a share in 1956. For the year 1957, sales amounted to $2,009,043,000, net income $72,652,000 equal to $4.18 a share; and for 1956 sales reported were $1,525,375,000, net income $3,492,000 equal to 10¢ a common share.

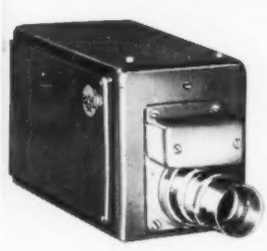
Δ The shareholders of Universal-Cyclops Steel Corp. approved the acquisition of the Empire-Reeves Steel Corp. as a wholly owned subsidiary.

Δ Wheeling Steel Corp. shut down its Mingo Junction, Ohio, plant for an estimated one-month period.

ON A FURNACE LINE AT A LARGE EASTERN STEEL PLANT

Furnace Operator

"SEES THE END FROM THE BEGINNING" with RCA Industrial Television!



To permit the operator to see around a long furnace line in an alloy plate building at a prominent steel plant, RCA Industrial TV is used. One-man control of the line from beginning to end is thus possible. Six Television Cameras are connected to TV monitors in the control room. A switching arrangement enables the operator to "switch-in" for observation of the blind areas, some of which are more than 600 feet away. He sees everything that's happening and knows when it's safe to move a plate from the quench press.

Other uses for industrial television include remote observation of rolling mills and shears; heat treatment, open hearth and blast furnaces; smoke stacks, fuel burners. Wherever control of vital instruments, processes, or materials is required, RCA Industrial TV can be counted on for reliable, accurate performance . . . designed and produced by the world leader in electronics.

An RCA representative will gladly help you determine how RCA Closed Television can best serve you. Mail coupon below for free literature.

Mark of Quality RCA Tmk(s) ®

RADIO CORPORATION of AMERICA
Camden, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

RCA CLOSED TELEVISION

Radio Corporation of America
Dept. C188, Building 15-1, Camden, N.J.

☐ Please send me latest literature on the use of RCA Industrial TV (Closed Television).

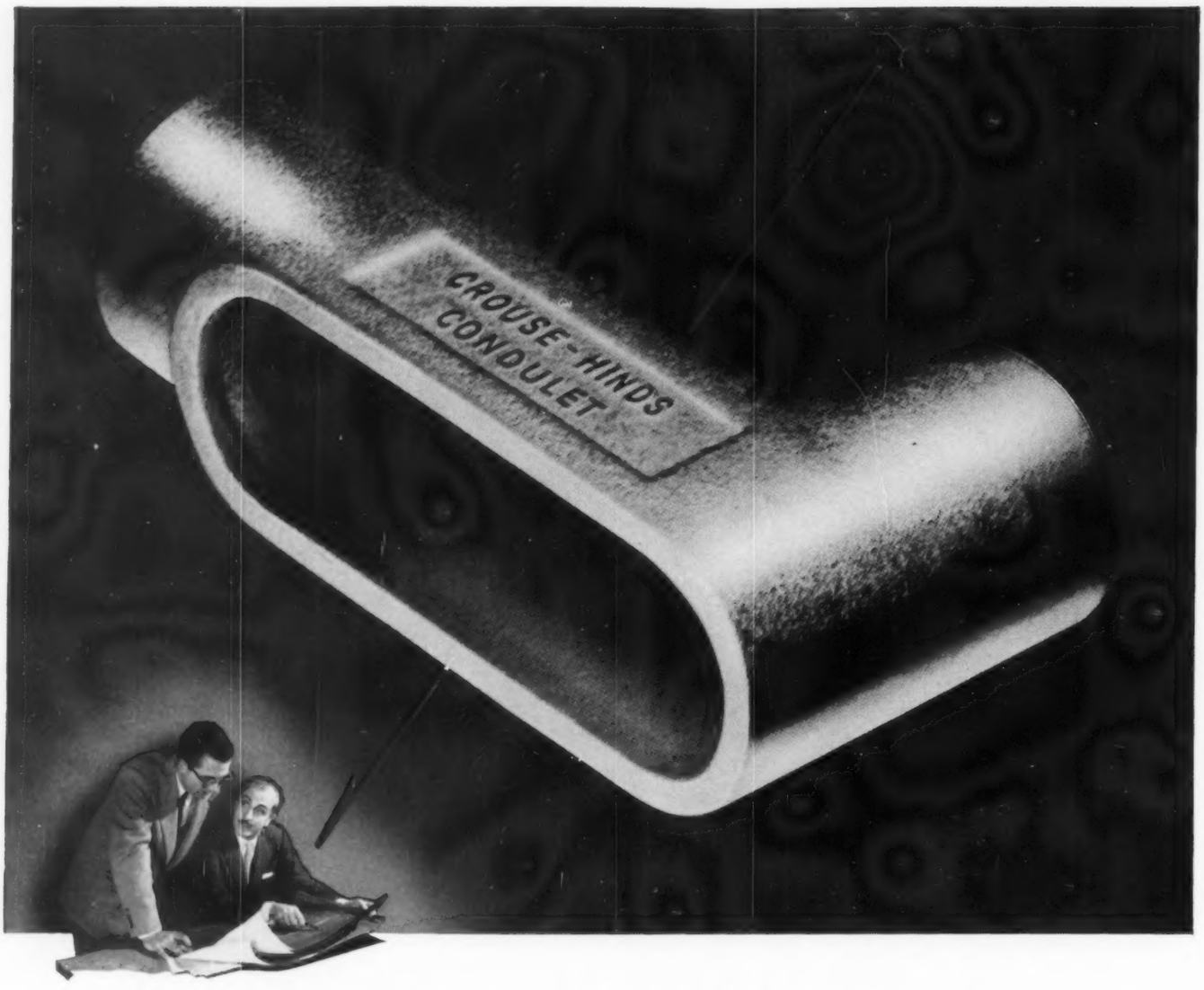
Name _____ Title _____

Company _____

Address _____

City _____ Zone _____ State _____

☐ Have representative call.



Now, more than ever, engineers specify: "CONDULETS*... or approved equal"

After 51 years of use in every conceivable application, Condulets remain the standard of quality for rigid conduit fittings.

It's not hard to see why. Pick up any Obround Condulet, for example, and note such features as these:

TAPER TAPPING: Condulet threads are taper tapped to match tapered conduit threading . . . giving you a rigid joint that will not loosen... insuring *permanent* ground continuity!

INTEGRAL BUSHING: A smooth, rounded, burr-less surface that protects wire insulation.

WEDGE NUT COVER FASTENER: This exclusive Crouse-Hinds feature is part of the cover itself. Screws can't fall out. No screw holes to locate. No protruding screw hole ears to damage cable.

LONGER HUBS: Conduit can be tightened completely without bottoming on integral bushing. And there's generous surface space for good wrench hold.

MATERIAL: Feraloy, a special alloy that is strong and tough, resists corrosion . . . gives sharp, full threads.

FINISH: A triple-layer treatment that exceeds Federal and U.L. specs for longer-lasting protection.

Where else can you find all (or even *most*) of these features? You *can* find them all in each of the 45 types of Obround Condulets . . . sizes ⅛" to 6".

There is a type for every need, including a wide selection of interchangeable covers and wiring devices. Just call your Crouse-Hinds distributor and ask for "Condulets!"

*CONDULET is a coined word registered in the U.S. Patent Office. It designates a product made only by the Crouse-Hinds Company.

CROUSE HINDS

MAIN OFFICE AND FACTORY: SYRACUSE, NEW YORK

Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.

• CONDULET® ELECTRICAL EQUIPMENT (Explosion-Proof and Conventional) • FLOODLIGHTING
• TRAFFIC CONTROL SYSTEMS • AIRPORT LIGHTING and WEATHER MEASURING EQUIPMENT

These products are sold exclusively through electrical distributors. For application engineering help, contact one of the following offices: Baton Rouge Birmingham Boston Buffalo Chicago Cincinnati Cleveland Corpus Christi Dallas Denver Detroit Houston Indianapolis Kansas City Los Angeles Milwaukee New Orleans New York Philadelphia Pittsburgh Portland, Ore. Salt Lake City St. Louis St. Paul San Francisco Seattle Tulsa Washington **Resident Representatives:** Albany Atlanta Baltimore Charlotte Chattanooga Jacksonville Reading, Pa. Richmond, Va. Shreveport

North American

GROWS*

by popular demand
for superior

Burners
Blowers
Controls

plus service

North American's staff of 58 combustion and control engineers can help you

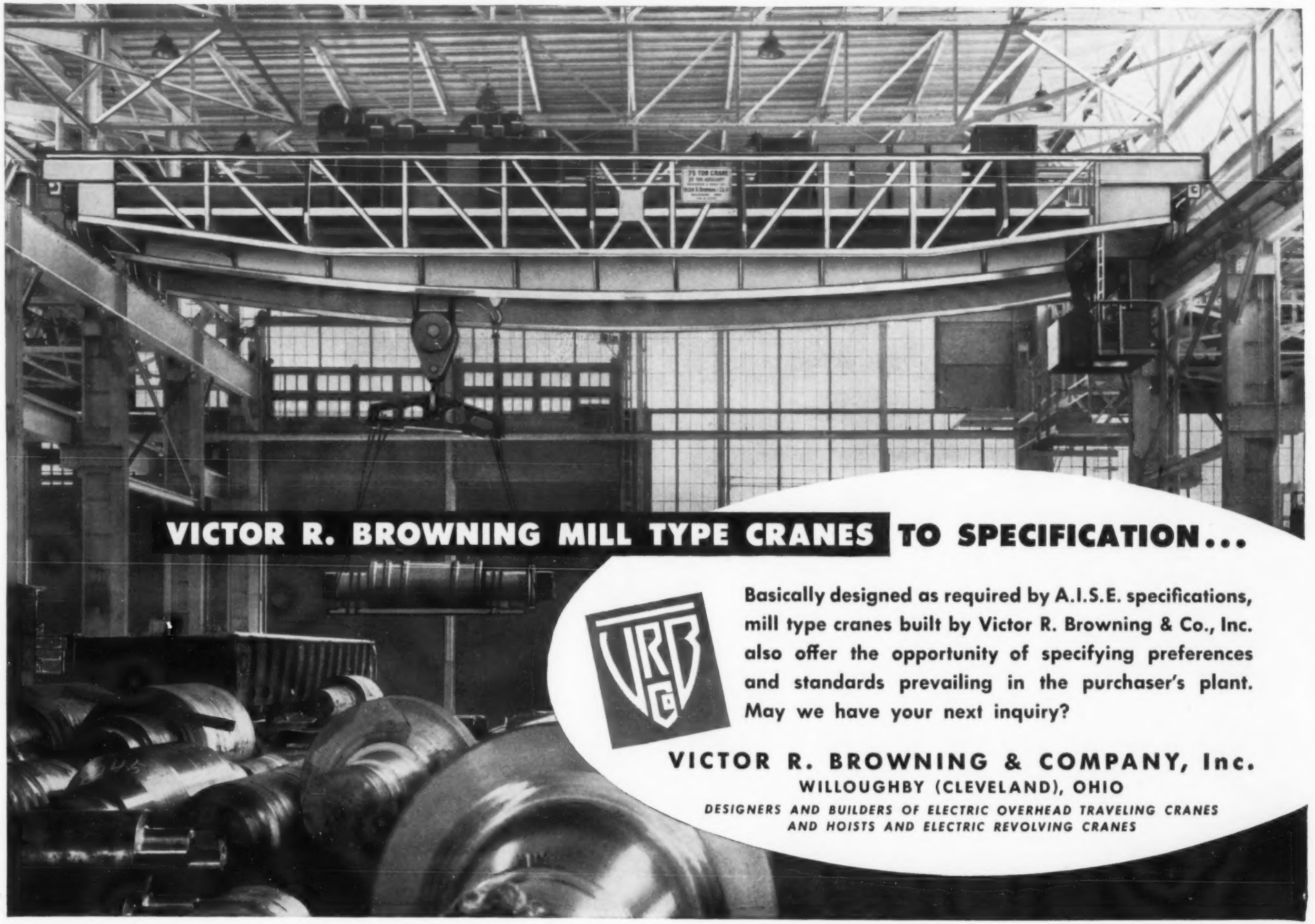
Save Money By

saving fuel
increasing production
improving product quality
bettering safety performance
achieving temperature uniformity
insuring cleanliness and less maintenance

*Photos show plant growth in the last ten years, but North American's experience has been growing since 1917

NORTH AMERICAN COMBUSTION Since 1917

The North American Manufacturing Co.
COMBUSTION ENGINEERS
CLEVELAND 5, OHIO



VICTOR R. BROWNING MILL TYPE CRANES TO SPECIFICATION...

Basically designed as required by A.I.S.E. specifications, mill type cranes built by Victor R. Browning & Co., Inc. also offer the opportunity of specifying preferences and standards prevailing in the purchaser's plant. May we have your next inquiry?

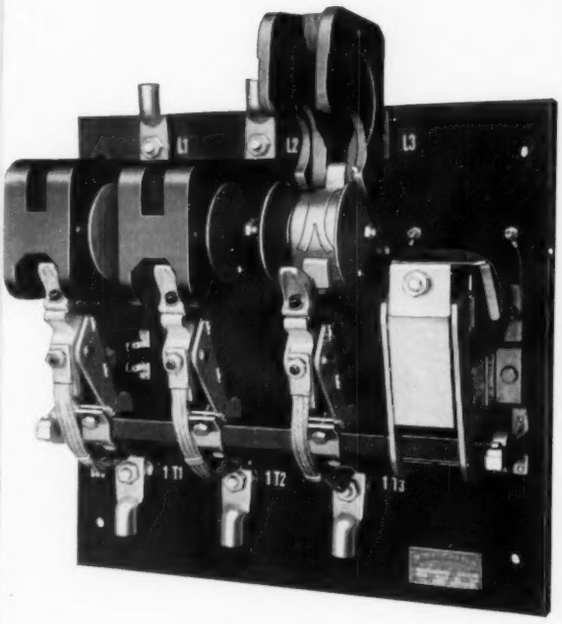
VICTOR R. BROWNING & COMPANY, Inc.

WILLOUGHBY (CLEVELAND), OHIO

DESIGNERS AND BUILDERS OF ELECTRIC OVERHEAD TRAVELING CRANES AND HOISTS AND ELECTRIC REVOLVING CRANES

HEAVY-DUTY

300-AMPERE CONTACTOR



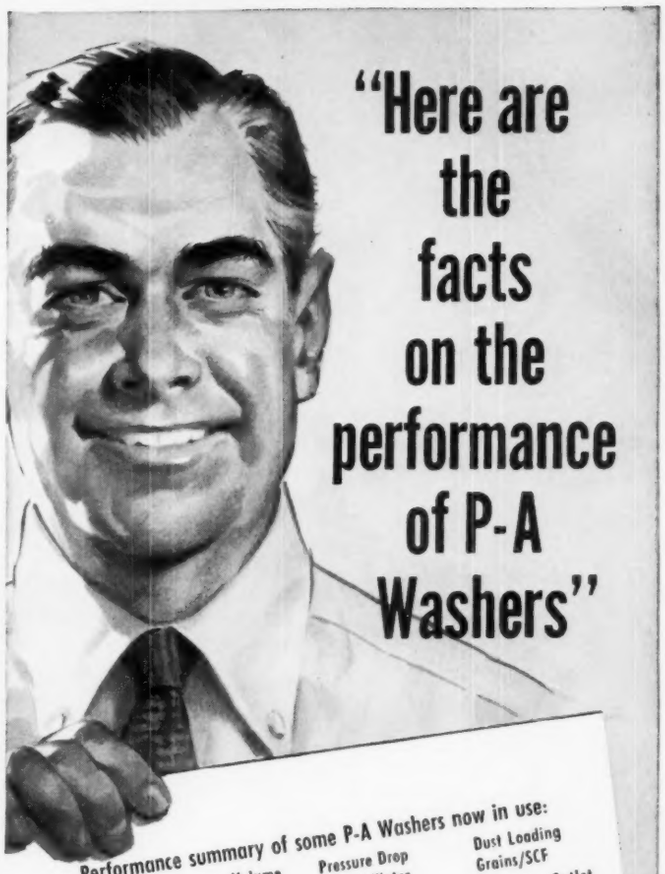
1 *Blows out arc faster.*
2 *Speeds operating cycle.*
3 *Reduces maintenance.*
4 *Operates quietly.*
5 *Lengthens contact life.*
6 *Provides horizontal or vertical mechanical interlocking.*
7 *Combines maximum structural strength with minimum weight.*

While this mill-type contactor was specifically designed for starter, machine-tool and crane applications, it is finding use in all types of service where severe operating conditions place a premium on lasting performance.

WRITE FOR BULLETIN 5005

THE EUCLID ELECTRIC & MFG. CO.
MADISON, OHIO

THE EUCLID ELECTRIC
EUCLID
AND MFG. CO., MADISON, O.



"Here are the facts on the performance of P-A Washers"

Performance summary of some P-A Washers now in use:

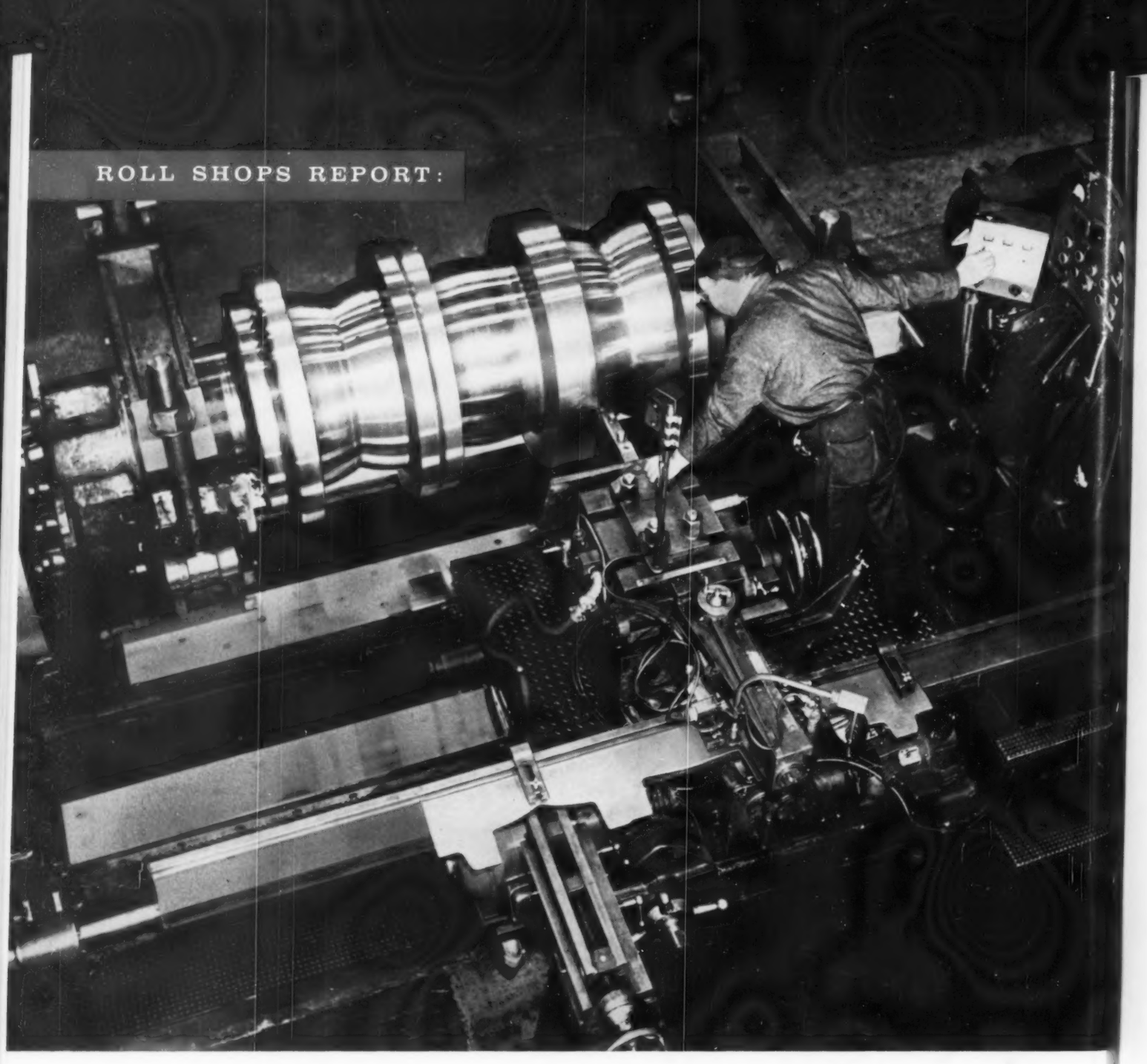
Installation	Years Operated	Volume SCFM	Pressure Drop Inches Water	Dust Loading Grains/SCF Inlet	Dust Loading Grains/SCF Outlet
A	4	78,000	30	3-19.0	.01-.04
B	3½	78,000	30	2-3	.02-.08
C	3	85,000	30-40	2-3	.01-.03
D	3	45,000	30	2	.02-.03
E	½	75,000	50	—	.02
F*	½	26,000	12	5	.10
G*	½	26,000	12	5	.10
H	½	90,000	29	—	.04

*Two units in parallel on one furnace. Lower efficiency due to lower available top pressure

These actual performance figures reflect the highly efficient operation of the Pease-Anthony washer. This venturi scrubber puts your full top pressure to work cleaning the gas. No secondary cleaner required for most installations. Present users report no maintenance problems. If you have a blast furnace scheduled for construction or rebuilding, plan now for P-A Venturi installation. Capacities up to 150,000 SCFM. Write for bulletin M-103.

CHEMICO
P-A GAS SCRUBBERS

CHEMICAL CONSTRUCTION CORPORATION
A Subsidiary of Electric Bond and Share Company
525 West 43rd Street, New York 36, New York
Telephone LOngacre 4-9400
Technical Representatives Throughout The World
Cable Address: CHEMICONST, N. Y.



"The skill's built in...and it does the work of three!"

What are your most urgent roll problems? A growing work load...high roll turning costs . . . a shrinking supply of skilled roll turners? *If that's the case, you're no different from 90 per cent of steel mill roll shops.*

Mack-Hemp Automatic Contouring lathes solve these problems for you. They reduce turning time by taking off more metal in one hour than a roll turner can in three or four on a block lathe. Yet Mack-Hemp lathes accurately reproduce within 0.001-inch complicated roll patterns from ful-size templates by means of an electronic "pilot."

That's why many leading steel mill roll shops are using Mack-Hemp contouring lathes and why a number of others have ordered them.

To find out how these lathes can help you, drop us a line today.

MACKINTOSH-HEMPHILL
Division of E. W. BLISS Company
Pittsburgh and Midland, Pa.

MACKINTOSH-HEMPHILL DIVISION · PITTSBURGH-U.S.A. · BLISS

Industry News...

MODERNIZATION PROGRAM UNDERWAY AT DUQUESNE

△ Work on United States Steel Corp.'s largest current modernization program in the Pittsburgh District has started at Duquesne Works.

Three new primary rolling mills will replace less extensive facilities now in operation at the plant. These mills—a high-lift, blooming-slabbing mill with work rolls 46 in. in diam, a blooming mill with 36-in. rolls and a billet mill with 21-in. rolls—are designed to speed and increase the production of semi-finished steel.

Scheduled for operation in 1959, the new mills and auxiliary equipment will be housed in five connected buildings stretching 2500 ft along the Monongahela River side of the plant area.

The structures, which will be erected by U. S. Steel's American Bridge Division, will shelter new ingot stripping facilities, seven banks of soaking pits and the three new mills. They will range in width from 90 ft to 250 ft.

John W. Price, Jr., (left) newly appointed general superintendent of U. S. Steel's Duquesne Works, is briefed by his immediate predecessor, Robert W. Graham, Homestead District Works general superintendent, as excavating work is started at the site where Duquesne's new primary mills are to be built.

Also to be installed in the various buildings are an automatic scarfing machine; shears and saws; seven batch-type, slow-cool furnaces for certain types of steel billets, and product-handling equipment for all three mills.

Still other facilities to be installed in the buildings or on the site include cranes, railroad tracks, and utilities and services.

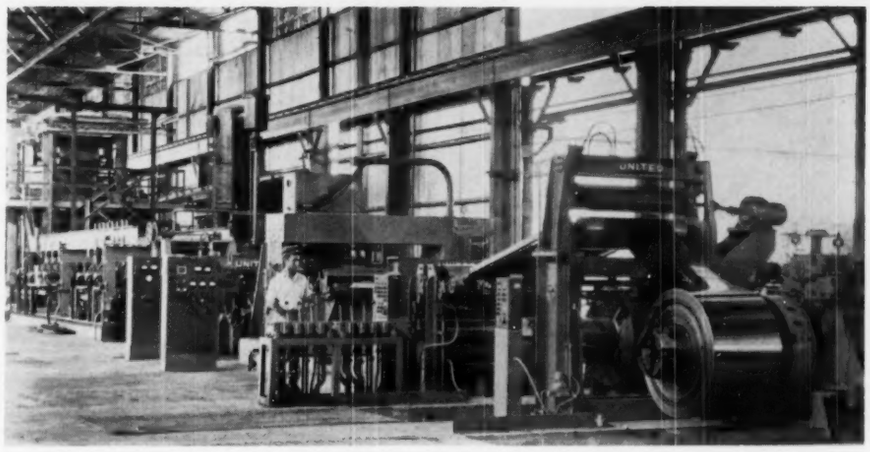
The completely modern mills, which form the heart of the project, not only will enable Duquesne Works to expand its output of blooms and billets, but also will permit the plant to roll slabs. This means that stainless steels from the Duquesne Works' electric furnaces and carbon steel from its open hearths, destined for rolling into plates or sheets, will first be rolled into slabs at Duquesne before shipment to other plants.

Blooms and billets produced on the new mill will, for the most part, be processed into the various types of steel bars produced at Duquesne Works.

In addition to production gains, enhanced quality of primary mill products is anticipated as a result of the program.

The older primary mills now operating will be dismantled after the new equipment is tested and placed in production.

NEW TINNING LINE INSTALLED AT ALTOS HORNOS



Installation of the first electrolytic tinning line for the continuous production of electro-tinplate in Mexico has been completed by United Engineering and Foundry Co. Purchased by Altos Hornos de Mexico, this new Ferrostan type line, incorporating the latest engineering features, has a maximum speed of 400 fpm, is about 200 ft in length and handles coils, weighing up to 22,500 lb, of cold rolled strip 18 in. to 38 in. wide, and from 0.0075 in. to 0.015 in. thick. United is also building a new blooming and slabbing mill and a 4-high reversing cold mill for Altos Hornos.

GRANITE CITY INSTALLS NEW SHEET CORRUGATOR

△ A giant sheet steel corrugator has been installed at the Granite City Steel Co. to fabricate the line of steel construction products marketed by Granco Steel Products Co., wholly-owned subsidiary.

With the new corrugator, Granco will be able to increase the maximum sheet length of its product for floor and roof construction to 21 ft, 6 in. from the present 14 ft, 4 in., thus increasing the potential use in structures requiring longer spans.

The new corrugator stands 15 ft high and weighs about 300,000 lb. The upper and lower mandrels are 21 ft, 6 in. long, and each mandrel weighs 36 tons. Each mandrel has mounted on it three different patterns of corrugating dies, so that the corrugator can produce several different products without the necessity of changing dies.

Development work for the new corrugator dies was done on a pilot

New Wheelabrator® Ultra-Filtration keeps control room air "vacuum" pure

Wherever ultra-clean air is essential, as in this electrical equipment control room of a leading steel mill, low-cost Wheelabrator **Ultra-Filtration** provides the most effective and economical method you can employ.

Ultra-Filtration removes even the most minute particles of foreign matter from the atmosphere, leaving the air cleaner than clean — as close to absolute purity as any practical means can achieve.

Control and motor rooms, laboratories, instrument and spectograph areas — or areas that must have dependably and consistently pure air — are best protected by Wheelabrator Dustube Ultra-Filtration. Machinery and instruments function more consistently with minimum downtime and maintenance caused by air-borne contaminating particles. And the Ultra-Filtration unit itself works continuously and automatically, with no attention and practically no maintenance cost.

For detailed information write today for Bulletin No. 558-D

WHEELABRATOR
CORPORATION

396 South Byrkit Street, Mishawaka, Indiana
Canadian Offices: Scarborough (Toronto) – Montreal

corrugator at Granco Steel Products' research laboratory, and design work was done by Granite City Steel's engineering department. The dies are made of close-grained semi-steel machined to tolerances of 0.002 in.

The new die patterns give Granco products from 33 to 60 per cent greater strength than they have had before by making more effective use of the steel.

Built by Stamco, Inc., the corrugator is powered by a 100-hp d-c motor through a gear reducing box which powers the top roll as well as the bottom.

Steel sheets are fed into the corrugator from a feed table also designed by Granite City Steel's engineering department. Brightly colored hooks or "dogs," into which new sheets are placed, move across the feed table toward the corrugating rolls. If the sheet is placed in the red hooks, it feeds through dies which form roof deck. If it is placed against white or orange hooks, other products are fabricated.

One problem which was encountered—and overcome—was elimination of all "play" in these hooks so that both ends of a sheet would be fed into the rolls at exactly the same time.

The corrugator contains a specially-conceived hydraulic system which permits the top corrugating roll to be raised or lowered. While the bottom roll remains stationary, the top roll may be raised as much as 2½ in. above the point at which gears mesh, or lowered ½ in. below this point. In this way the corrugated depth of the fabricated products can be varied to produce sheets with a maximum corrugated depth of 4½ in.

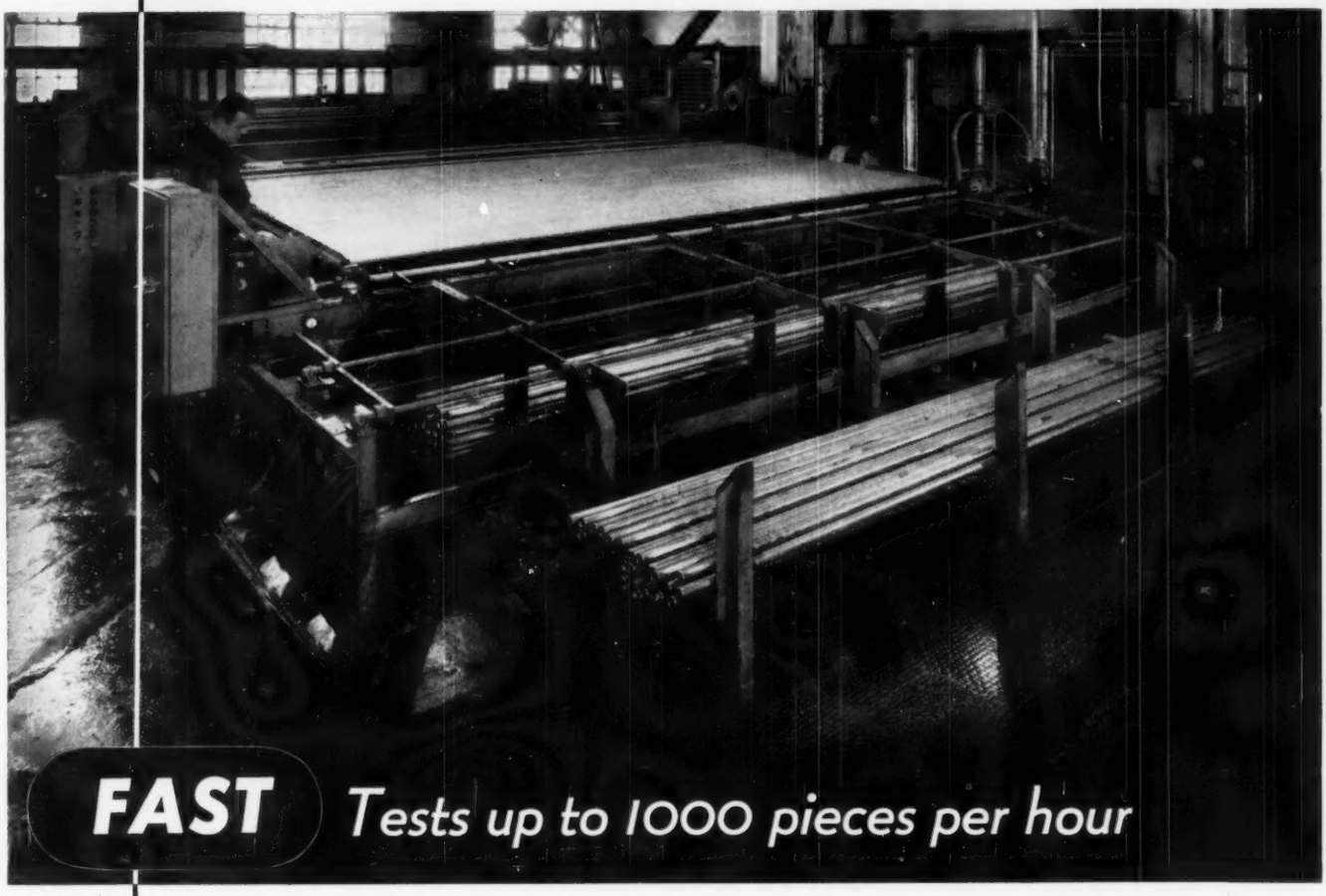
The new corrugator is equipped with a special pressure lubrication system which prevents operation until enough pressure is built up in each of the lubrication lines.

TEXAS PLANT EXPANSION NEARING COMPLETION

△ Gulf States Tube Corp., Rosenberg, Texas, which went into operation in March 1957, has announced an expansion program. A subsidiary of Michigan Seamless Tube Co., Gulf States Tube expects to have its new facilities ready for operation during March.

The addition consists of a build-

NEW WELDCO Pipe Testing Machine



WELDCO Installation in the St. Henry Works of The Steel Co. of Canada, Ltd.

WELDCO Automatic Pipe Testing Machines test up to 1,000 pieces of pipe per hour . . . 1/2" through 4" in single, random lengths.

- Fully automatic on uniform lengths, and require only one man to operate.
- Maximum test pressure up to 5,000 psi.
- Low initial cost.
- Controls are all on one panel—for convenient, fast operation.
- Easy manual adjustment for random lengths—in a matter of seconds!
- Advanced design . . . for low-cost maintenance and trouble-free operation.

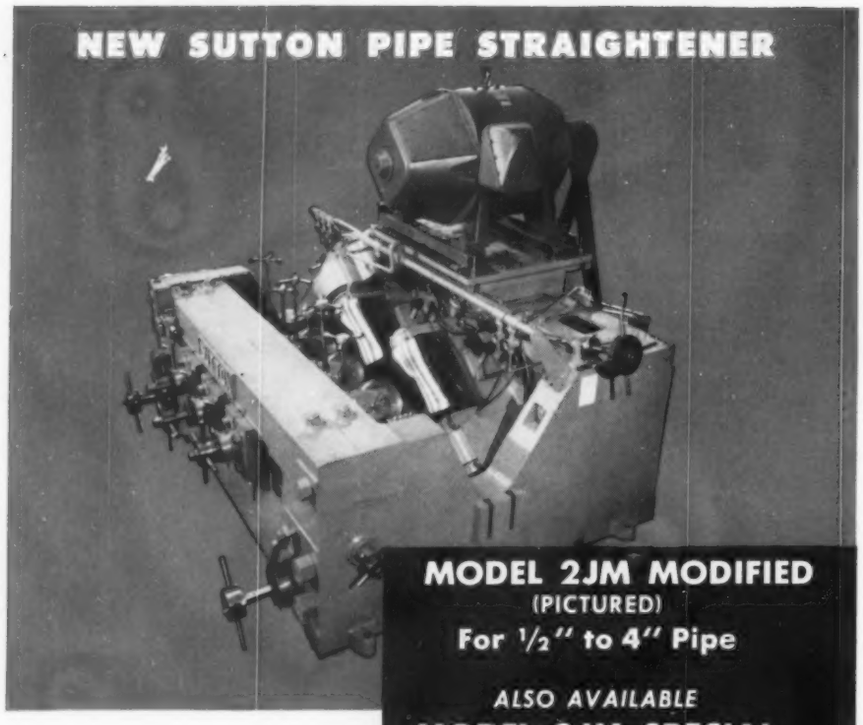
It will pay you to get the rest of the story. Just phone or write us today.

WELDCO

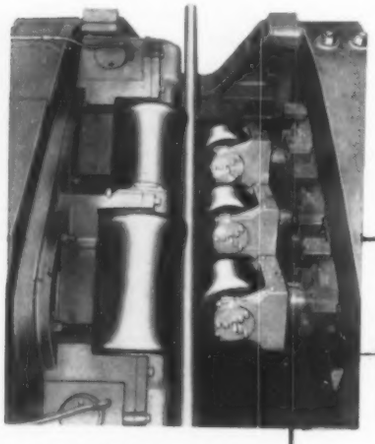
THE YOUNGSTOWN WELDING & ENGINEERING CO.
3724 OAKWOOD AVE. • YOUNGSTOWN 9, OHIO

STRAIGHTEN *PIPE*

AT 1000 FPM and FASTER!



Specifically designed to meet the demands of today's continuous-weld pipe mills for steady, dependable production at highest straightening speeds



- DEPENDABLE SERVICE
- HIGH PRODUCTION
- QUALITY STRAIGHTENING
- EASY SCALE DISPOSAL

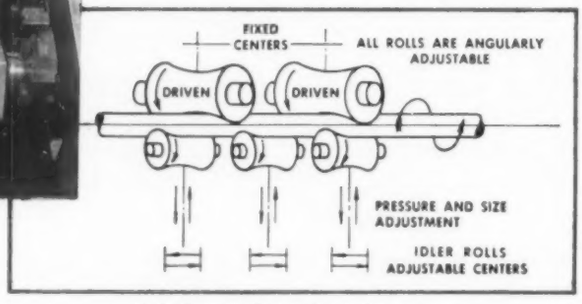


Photo and diagram of 5-roll design shows engineering principle of driven rolls with opposed idler rolls.

Ask for Bulletin No. 25

SUTTON *Engineering Company*

FIRST NATIONAL BANK BLDG., PITTSBURGH 22, PA.
PHONE: GRANT 1-8077 PLANT: BELLEFONTE, PA.

Manufacturers of Straighteners, Hydraulic Extrusion Presses, Centerless Bar Turners, Rotary Swagers, Sheet Levellers and other Finishing Machines for Modern Metals.

ing of approximately 12,000 sq ft, housing a twelve-stand, three-roll, reducing mill, a roll-down type furnace and the necessary accessory equipment. New straightening, finishing, and coating equipment will also be installed.

This expansion will allow an increased volume of seamless cold drawn tubing to be produced at Rosenberg and will expand the field of products to include small diameter hot finished seamless pipe.

REYNOLDS TAPS FIRST POTLINE AT LISTERHILL

△ Reynolds Metals Co. tapped the first of three potlines in its new Listerhill aluminum reduction plant at Sheffield, Ala., on January 16. Two more potlines in the plant are scheduled to go into service in the spring and early summer.

The three new potlines will have a rated capacity of 112,500 tons of aluminum per year.

The new plant is adjacent to the recently modernized Listerhill reduction plant with which Reynolds entered the primary aluminum producing field in 1941. This plant is operating at full capacity. Total annual rated capacity of the new and old plants is 190,000 tons.

A substantial part of the production of the new plant will be used by the adjacent Ford Motor Co. foundry, which takes the metal in molten form.

Aluminum from the new plant not needed by the Ford foundry will be delivered in molten form to the adjoining Reynolds fabricating plant or cast into pig and ingot form.

PENN STATE ANNOUNCES TWO SUMMER COURSES

△ The Pennsylvania State University, University Park, Pa., announces that it will conduct two short courses next June and July.

The first course on "Materials Engineering Design for High Temperature" will be held June 29 to July 3, 1958 on the Penn State Campus. The subject matter which is closely allied with today's emphasis on research and development will include metallurgical properties, mechanical static properties at high temperature, thermal shock and fatigue properties, and design for high temperatures. Lectures will be

given by a number of prominent engineers and scientists in the field.

The second course on "Mechanical Properties of Materials," intended to keep design engineers and others engaged in research on materials abreast of new developments in the field, will be in session from July 7 to 11, 1958 at the Pennsylvania State University.

Subjects to be covered will include hardness of metals, plastic behavior of metals under simple and combined stress, creep resistance and high temperature properties of metals, fatigue strength of metals, effects of radiation on metals, recent developments in testing machines and instrumentation, and metals under high-speed loading.

Further information on these courses may be obtained by contacting, for the first course, Joseph Marin, and for the second course, either Joseph Marin or L. W. Hu, Department of Engineering Mechanics, The Pennsylvania State University, University Park, Pa.

J & L ACQUIRES ACREAGE FOR IRON ORE RESERVES

△ Jones & Laughlin Steel Corp. has announced the purchase of approximately 300 acres of land in Wisconsin, and the leasing of an additional 1720 acres as a part of its iron ore reserve program. The corporation has no plans for the immediate development of the acreage.

The lands are located in Iron and Ashland counties. A total of 226 acres has been purchased from three owners near the village of Butternut, Ashland county, 80 acres purchased in Iron county, and an additional 1720 acres leased in Iron county, mainly from the county itself.

These lands were optioned by J&L for exploration work in 1954 and 1956. Geologic and geophysical studies and diamond drilling have been carried out on the properties.

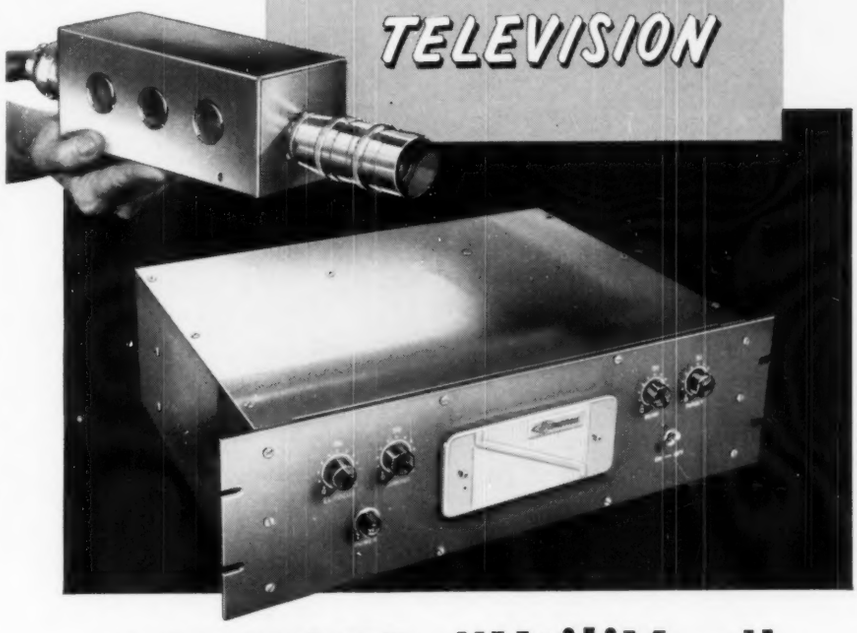
This exploration confirmed the presence of economic quantities of magnetic iron formation, or taconite, which can be recovered by open pit mining.

These are the so-called "low-grade" ores, which may be beneficiated to produce a high grade iron product for blast furnace use.

(*Please turn to page 198*)

ANNOUNCING . . .

An Important Improvement in INDUSTRIAL TELEVISION



DIAMOND "UtiliVue"
MODEL 500
CAMERA SYSTEM

This new industrial television camera and control unit provide a sharper picture with finer detail. The 500 has automatic compensation for wide variations in light on the scene viewed . . . assuring a good picture with any reasonable illumination. Picture quality is maintained automatically under wide fluctuations in line voltage.

The miniaturized camera is exceptionally compact and easy to use. The controls are simple and can be remotely located from the camera. As many as five cameras can be used with one control unit by means of a Diamond camera switcher.

Diamond Industrial Television can save you money . . . improve operation . . . increase safety. For further information, get in touch with your nearest Graybar office or use the coupon below.

Diamond

7820

Graybar Distributed by Graybar Electric Company

In over 130 principal cities

DIAMOND POWER SPECIALTY CORP.
"FIRST IN INDUSTRIAL TELEVISION"
ELECTRONICS DEPT., P.O. BOX 58G
LANCASTER, OHIO

Please send me without obligation a copy of new bulletin showing how Diamond Industrial (Wired) Television will help me reduce costs, improve quality, increase sales and aid safety.

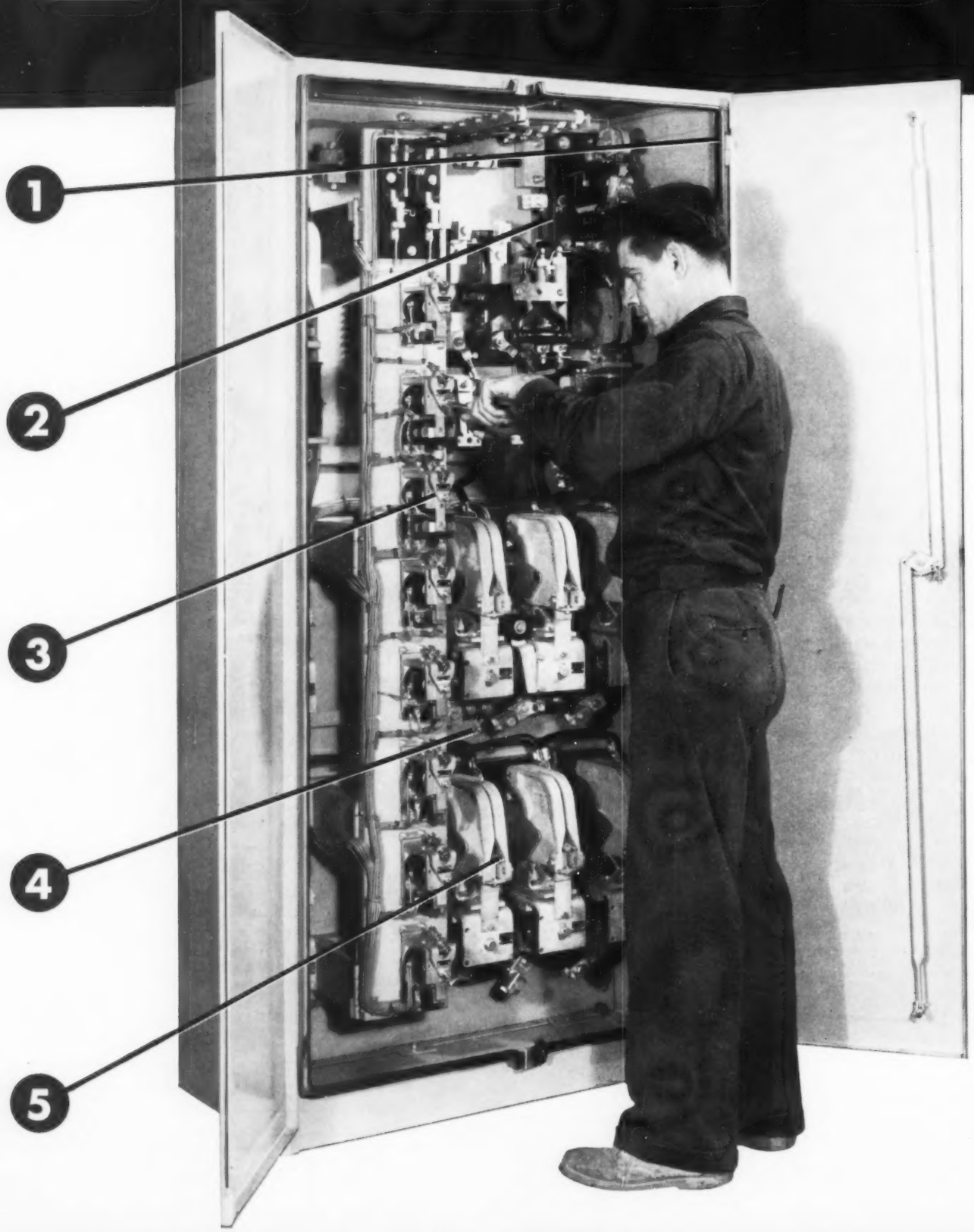
Name_____

Title_____

Company_____

Address_____

NEW



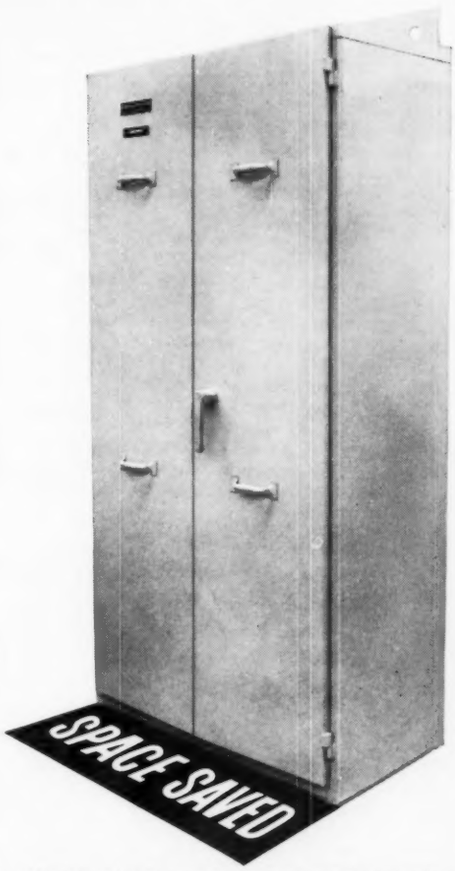
all front-connected d-c crane control from General Electric

SMALL SIZE AND ELIMINATION OF BACK AISLE CUT FLOOR SPACE REQUIREMENTS IN HALF!

General Electric announces the only completely front-connected d-c crane control panel on the market today! This new design feature eliminates any need for a back aisle. And here are five *more* reasons why General Electric is your best buy in d-c crane controls:

1. **Doors are quickly removed,** if desired, to provide ample room for installation and maintenance. The doors are hung on hinge pins to simplify removal. The lower pin is shorter than the top pin for ease of replacement.
2. **Devices are better protected** against shock and vibration by mounting on shock-resistant unit-bases. This construction also permits removal of devices as individual units from the front.
3. **Adjustable devices are readily accessible** because they are mounted on a hinged panel near the front of the enclosure. This panel swings open to provide access to a vertical wiring channel for the inter-connecting cables.
4. **Connections are made easy** by convenient terminals. Built-in wire troughs are formed by unit bases of individual devices.
5. **Spare parts are minimized** by use of rugged steel-mill devices, all of which use the same universal interlock for contacts on relays, and for auxiliary contacts on contactors.

Take advantage of this new space-saving design now. *Specify General Electric d-c crane controls!* Ask your General Electric sales engineer for information on the outstanding performance characteristics of General Electric d-c crane control. Or write for GEA-6434, to Section 785-3, General Electric Company, Schenectady, New York. Industry Control Department, Roanoke, Virginia.



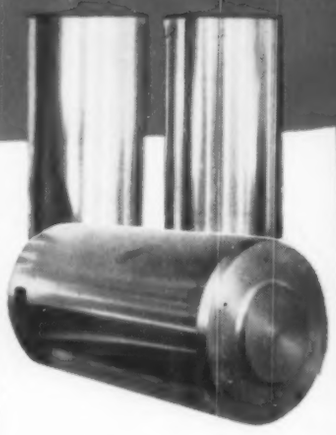
UP TO 50 PERCENT LESS FLOOR SPACE is required by eliminating the back aisle and the use of a smaller panel enclosure.

Progress Is Our Most Important Product

GENERAL ELECTRIC

RED CIRCLE Rolls ALLOY-CHILLED

Hyde Park RAMS



for all types of HYDRAULIC EQUIPMENT

Hyde Park Rams are available in Chilled or Alloy Iron.

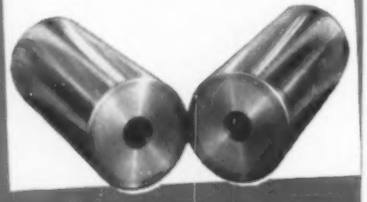
Furnished in hardness range to meet your specification . . . ground to your required size.

On your next replacement of Rams—or for new equipment—consult us. Our engineers will be glad to assist you.

Red Circle Rolls for every Purpose

Rolling Mill Equipment

Gray Iron Castings up to 80,000 lb.



Hyde Park

FOUNDRY & MACHINE CO.

Hyde Park, Westmoreland Co., Pa.

ROLLS

ROLLING MILL MACHINERY

GRAY IRON CASTINGS

(*Continued from page 195*)

ANNOUNCES TWO NEW EQUIPMENT ORDERS

△ The Aetna-Standard Engineering Co. announces two new equipment orders. They will furnish a 60-in. trim and shear line for the Campbell, Ohio plant of the Youngstown Sheet and Tube Co. They will build a new continuous butt weld pipe mill for Pittsburgh Tube Co.

The trim and shear line will process strip steel at speeds up to 1250 fpm. It will handle coils up to 62,000 lb, pack weights of 40,000 lb, widths from 24 in. to 62 in., 36 in. to 200 in. long.

The new pipe mill will produce cold drawn mechanical tubing for use by the automotive industry. Material from the mills will be further processed by cold drawbench operations to special O.D., wall, length and material hardness specifications. In some cases, tubing will be fabricated by forging or swaging. Annual capacity of the mill will be 50,000 net tons for a variety of sizes ranging from a minimum of 0.835 in. O.D. x 0.091 in. to a maximum of 3.500 in. O.D. x 0.450 in.

Both orders are scheduled for delivery late this year.

RUST-OLEUM COMPLETES EXPANSION PROGRAM

△ Completion of a two-year $600,000.00 plant expansion program was recently announced by Rust-Oleum Corp.

New production facilities in the manufacturing division include a three-story, 12,000-sq ft warehousing unit as well as the installation of new ball mill equipment and a new automatic packaging system.

The expansion program represents the sixth major increase in Rust-Oleum plant facilities since 1946.

ALLIANCE BUILDS MIAMI ENGINEERING OFFICE

△ Alliance Machine Co. is building its own modern building on 2901 South Bayshore Drive, Miami, Fla. Built to house an engineering staff of 125, this new office has become necessary because of the rapid growth of Alliance's activities in this area.

Five years ago Alliance opened an engineering office in Miami with five engineers to handle their Minit-Park operation which is an automatic car parking system. Because of the availability of young engineers and outstanding retired men in the vicinity, Alliance subsequently transferred much of its engineering work to this office and this, in turn, has necessitated the new building. It provides also a logical outlet for the company's service and products in the Mexican and South American markets.

FIRM ANNOUNCES CHANGE OF CORPORATE NAME

△ NADCO Engineering Co. announces the acquiring of a Pennsylvania corporation charter. The board of directors has named Steve Darko as president. Mr. Darko was formerly owner and general manager of National Design & Detailing Co., whose activities will now be continued under the new name.

LOS ANGELES PLANT OPENED BY LINK-BELT

△ Link-Belt Co. officially opened its new Los Angeles, Calif., plant January 16.

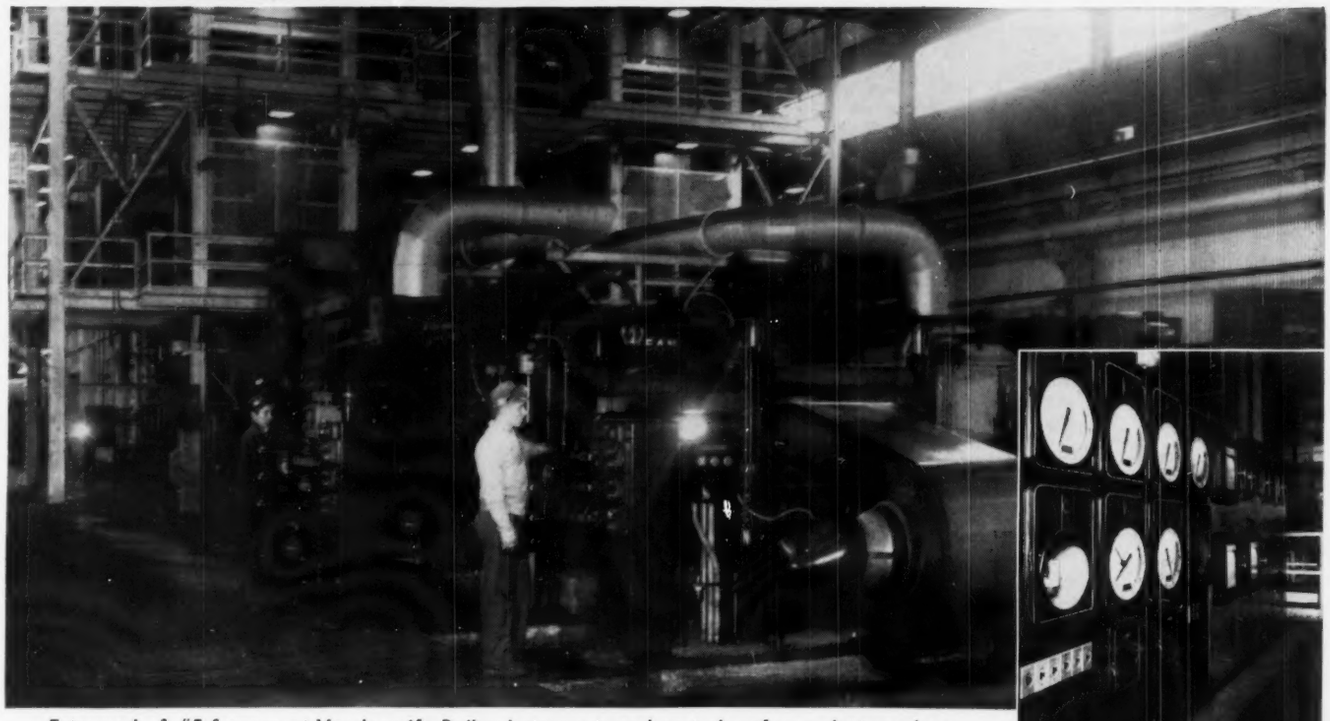
The new plant more than doubles the production facilities of the previous Los Angeles plant, and houses not only manufacturing facilities, but the engineering department, district sales office and factory branch store.

TO BUILD HOT STRIP MILL FOR REYNOLDS

△ United Engineering and Foundry Co. has received an order from the Reynolds Metals Co. for a hot strip mill for the production of aluminum plates and strip.

The mill will be the largest ever built for rolling aluminum having a continuous finishing train with roll bodies 120 in. long. The principal units will be an edging mill; a 170 in. wide 4-high breakdown mill; a 130-in. wide 4-high secondary mill; a slab shear; 4 stands of 4-high continuous finishing mills; two coilers and other auxiliary equipment. The unit is to be installed at Sheffield, Ala., and is scheduled for delivery during 1959.

HOW TO CONTROL ATMOSPHERES...



Entry end of #5 furnace at Vandergrift. Bailey instruments and controls safeguard atmospheres.

These Bailey Gas Analyzers monitor the atmosphere conditions in heating and cooling zones in the furnaces.

U. S. Steel uses BAILEY GAS ANALYZERS on continuous annealing line

At its Vandergrift, Pa., plant, U. S. Steel Corporation runs five lines for the continuous annealing of silicon strip steel used in making transformer and motor laminations. The furnaces are composed of a heating and cooling zone, each with its own protective atmosphere. Bailey Gas Analyzers are used to indicate that proper atmospheres are maintained for the protection of the product.

In starting up, furnaces must be thoroughly purged of all oxygen to prevent explosions. Bailey Oxygen Recorders determine completeness of purge before hazardous protective gas may be used. Bailey Combustibles Recorders are also used during purging as a check on the Oxygen Recorders. After purging, they analyze the incoming NX gas.

When operating, the furnaces are provided with the proper protective atmosphere composed of NX gas and dissociated ammonia. Bailey Hydrogen Recorders keep constant watch on the per cent hydrogen in the mixture. Bailey NX Gas and Dissociated Ammonia Flow Meters are used in regulating the total flow and composition of protective atmospheres.

As an additional safeguard, Bailey Furnace Pressure Recorders are used. These instruments control the protective gas flow to eliminate air infiltration into the furnaces.

Since 1948, when this Bailey equipment was installed, a perfect safety record has been maintained, yet purge time has been substantially reduced. Formerly purging was done on a time basis which was wasteful of gas and time. Steel quality has been uniformly high and high production has been maintained with the Bailey controls.

Whether your heat treating requires several huge continuous lines like these or one small batch-type furnace, Bailey Meter has the instruments and controls for you. See your Bailey Engineer or write to the Iron & Steel Division for additional information.

S11-1

BAILEY METER COMPANY

IRON AND STEEL DIV., 1047 IVANHOE ROAD, CLEVELAND 10, OHIO

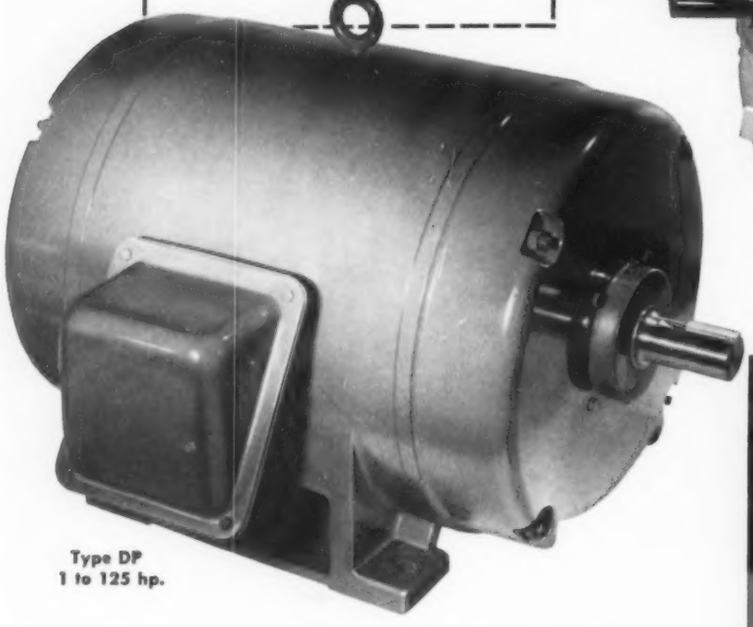
In Canada — Bailey Meter Company Limited, Montreal

INSTRUMENTS AND CONTROLS FOR POWER AND PROCESS

BAILEY METERS

BAILEY BUILDING BLOCK METHOD

WAGNER
POLYPHASE
MOTORS



Type DP
1 to 125 hp.

These open type motors give DOUBLE PROTECTION... can be used in many places that formerly required splashproof motors

Wagner Type DP Motors offer the *double protection* of rugged corrosion-resistant cast iron frames and dripproof enclosures so well designed that the DP Motor can handle many applications that formerly required splashproof motors.

These Wagner Motors are built in the new NEMA ratings that pack more power into less space, are lighter in weight and are easier to maintain—only occasional lubrication is required.

SLEEVE BEARING MODELS AVAILABLE

The entire line of ratings through 125 hp. is available with steel-backed, babbitt lined sleeve bearings that have high carrying capacity and provide quieter operation.

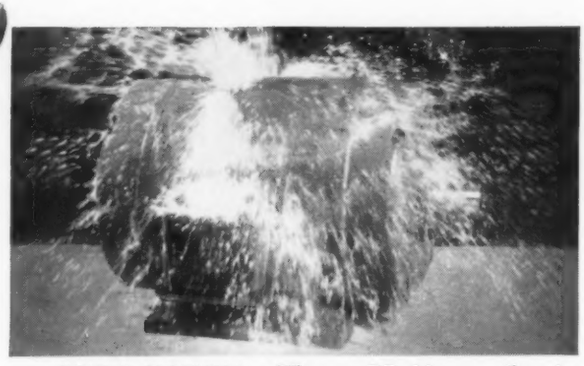
Let a Wagner Sales Engineer show you how these motors can be applied to your needs. Call the nearest branch office or write for Wagner Bulletin MU-223.

1 to 125 HP—1750 RPM—40°C NEMA FRAMES 182 through 445U

Wagner Electric Corporation
6483 Plymouth Ave., St. Louis 14, Mo., U.S.A.

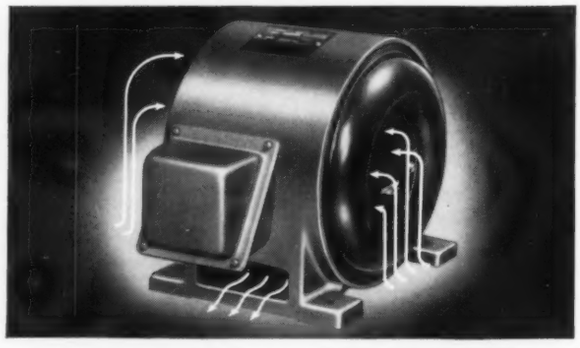
WM58-4

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES



DOUBLY PROTECTED — Wagner DP Motors offer the *double protection* of completely dripproof enclosures and rugged cast iron frames that can take rough handling and resist corrosion.

CAN BE RELUBRICATED — These motors can be re-greased when desired for longer bearing life. Fresh grease can be added—old grease removed—through openings provided in the ball bearing housing.



COOL RUNNING — Specially designed baffles direct cooling air through the motor to protect the stator windings. Blowers, cast as part of the rotor, move large volumes of air without noise or vibration.

Publication Service...

FEBRUARY, 1958

You Can Obtain . . .

. . . any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

Note: Post cards expire three months after publication date.

(1) Mill Motor

Design features of new Elliott Crocker-Wheeler 620 frame mill motor are detailed in a four-page technical bulletin. Electrical details are described, including design and construction of armature, armature coils and field coils. All coil insulation is Class H. Information on mechanical design features which contribute to reliable operation and ease of maintenance also is provided. Four types of enclosures are offered: totally-enclosed, non-ventilated; protected, self-ventilated; protected, forced-ventilated; and enclosed, forced-ventilated. (Bulletin PB-9000-2)

(2) Adjustable Speed Drives

The Louis Allis Co. has published a new 12-page bulletin on the "Select-A-Spede" adjustable speed drive. Applications such as machine tools, metal processing, textile, paper making, test stands, conveyors, etc., are discussed and illustrated in the bulletin. Also stressed are ease of installation, optional features for special applications and improvements in savings that can be effected by using this drive. (Bulletin No. 2000)

(3) Fork Truck Operation

Tips on operating fork lift trucks more safely are contained in an eight-page brochure available from Lewis-Shepard Products, Inc. Fully illustrated with a series of cartoon-type drawings, the booklet not only points out specific safe operating practices, but actually serves as a guide in setting up a fork truck driver training course. Among the topics discussed are selecting operators, classroom instruction, driving instruction and maintenance responsibilities of the trained operator.

(4) Pouring Pit Refractories

Refractories Div., H. K. Porter Co., Inc., has published a new four-page bulletin on pouring pit refractories for steel plants. Three types of ladle linings are illustrated by dimensioned engineering drawings to show "Rowlock" ladle linings, circle and cord brick linings and universal brick linings. Sleeves, nozzles, bottom pour brick and refractory hot tops for steel mills are described and illustrated by detailed cutaway drawings.

(5) Speed Control Drives

Packaged drives for equipment requiring adjustable speed or speed synchronization are described in a new eight-page bulletin available from the Clark Controller Co. The bulletin describes the company's packaged speed control drives, which incorporate in one package the elements of adjustable-voltage d-c drives. The bulletin explains the basic circuit, and the many modifications available including speed regulation, constant-potential d-c supply, dynamic braking and acceleration control. Major components are pictured and described. The bulletin explains drive features, lists and pictures typical applications and includes specifications. (Bulletin 20, 000)

(6) Centrifugal Pumps

Centrifugal pumps designed for continuous heavy-duty operation within the medium pressure range are described in a flier published by Ingersoll-Rand Co. This new flier includes cross-sectional views and a complete table of pump dimensions. (Form 7148-A)

(7) Circulating Oil System

Trabon Engineering Corp. announces a new bulletin on its Mark II "Meterflo" circulating oil system. The system controls a flow of oil in the moderate volume range to a multiple number of outlets regardless of varying back pressures or change in oil viscosity. Essential information for designers of machinery, etc., interested in the design and function of centralized lubrication. (Bulletin 574)

(8) Flow Meters

The Bristol Co. has published a bulletin of engineering data on differential pressure type flow meters. The 22-page illustrated bulletin gives basic information and theory on the selection, sizing and installation of the various types of primary devices. After an introductory section outlining the theory of head type flow rate meters, the basic primary devices, their uses and characteristics are described. Approved installation practices for gases, liquids and steam are explained and illustrated. Equations for calculating throat diameters and flow rates and finding manometer ranges are given with practical illustrative examples. A series of tables of appropriate data for flow calculations concludes the booklet. (Bulletin F 1607)

(9) Hydraulic Valves

A new catalog on manually operated, 4-way hydraulic valves has recently been published by Rivett, Inc. This 12-page catalog describes pipe connected, flange connected, and sub-plate mounted valves operated by lever, cam or foot. Specifications pertaining to each operation and mounting style are shown along with a cross-section view and illustrations of each model. Also included in the catalog are ordering instructions, optional features and graphs showing flow vs pressure drop. (Catalog Section 210)

(10) Axial Compressors

Design and construction features of axial compressors available in sizes from 8000 to 1,000,000 cfm

are described in a new bulletin released by Allis-Chalmers Manufacturing Co. Among the advantages cited for the axial compressor is its basically constant volume with variable pressure output; high efficiency, compact, streamlined design; flexibility and virtually trouble-free operation. (16B8863)

(11) Industrial Cars

Easton Car & Construction Co. has available a catalog discussing the design and construction of their custom built industrial cars. Fully illustrated, the catalog describes their transformer cars, all types of furnace and transfer cars for modern heat-treating systems, platform cars and yard and factory trailers. (Catalog C)

(12) Induction Motors

Large induction motors are described in a 16-page bulletin available from The Louis Allis Co. This bulletin presents detailed information on a full line of motors in ratings from 150 to 1250 hp. Cutaway drawings and illustrations show the protection offered by the open drip-proof, splash-proof, enclosed and explosion-proof enclosures in which these motors are built. Construction features emphasized in the bulletin are reliable bearing design and insulation. It also describes a wide range of optional features that are available to match individual job requirements. (Bulletin No. 1950)

(13) Connections for Overhead Lines

Comprehensive, up-to-date information on electrical connections for overhead lines in transmission and distribution is available from Burndy Corp. Basic principles of splicing, tapping, deadending and other applications are explained for the linesman as well as the engineer, with photographs, drawings and charts supplementing the easy-to-read text. Low resistance, stability under varied conditions, economical installation and other electrical connection requirements are covered. An entire section is devoted to recent progress in connecting aluminum. An illustrated selector chart makes it easy to find information on connectors for specific applications and types of conductors. Complete technical data on connectors, tools and accessories are organized for ready reference. (Catalog OH57)

(14) D-C Contactors and Relays

A new 32-page catalog on the company's complete line of d-c contactors and relays is now available from the General Electric Co. The publication covers the company's general purpose contactors, mill-type contactors, time-delay contactors, general purpose relays, timing relays, instantaneous-overload relays, thermal-overload relays, field-loss relays, field accelerating and decelerating relays, and high drop-out relays. Extensive selection and application data is provided, including ordering instructions, full product descriptions, photographs of representative units, and pertinent technical data. (GEA-6621)

(15) Turntables

Six standard types of manually operated ball bearing-mounted turntables are described in an illustrated four-page catalog offered by the Atlas Car & Mfg. Co. These are available in standard diameters of 36 in. to 96 in. of welded steel construction. Single and cross track units are shown in raised rail and flush rail models. The latter are provided with pit rings which serve as a curb for the concrete. Latches are standard for all models and are furnished for 90 degree turns. Also shown is the new adjustable center bearing design for manually operated turntables which minimizes turning effort. Illustrated are power operated models of up to 16-ft diam with capacities to 30 ton. (Bulletin No. 1297)

(16) Motor Control Selection

A 56-page catalog on electric motor control selection is available from Furnas Electric Co. The catalog includes a new special "Quick Selector" table giving horsepower, motor speed, heater size and heater ampere ratings plus enclosure choices and prices all combined in one easy-to-read table. Also included are design data, up-to-date prices, stocking information and complete ordering instructions for magnetic starters and contactors, drum controllers, pressure switches, push buttons and other motor control and pilot devices. (Catalog 5800)

(17) Cable Terminators

Delta-Star Electric Div., H. K. Porter Co., Inc., has released a 12-page catalog describing and illustrating their new line of Seal-Kap terminators (potheads). The booklet covers the new single-and-three-conductor cable sealing devices for indoor and outdoor service; corrugated and petticoat type bushings; 2.5 kv to 34.5 kv, 1/0 to 2,000,000 MCM cable. The first two inside pages feature cut-away photos and drawings with complete text to explain how these terminators offer ease of installation, assurance of a permanent seal against moisture, voidless compounding and a wide range of sizes and entrance fittings to meet most applications. There are eight pages of charts, drawings, and tables giving voltage ratings, maximum conductor sizes with AWG or MCM of internal connectors, bore in porcelain, porcelain symbols, catalog numbers, dimensions, packed weights and compound required. Cable entrances, insulating compound and bushings are simply designated and charted. (Publication 5703)

(18) Hydraulic Surface Grinders

The Hill Acme Co. has published a comprehensive bulletin describing their hydraulic surface grinders. Horizontal spindle, vertical spindle and extra heavy duty double housing models are included. Clearly illustrated, the bulletin gives full details of construction such as the horizontal spindle column, the electrical control panel, grinder table and hydraulic as well as manual cross-feed operation. Also included are specifications with complete dimensions for these grinders. Grinder tables range from 8 to 40 ft in length.

(19) Metalworking Presses

A 12-page bulletin that describes applications and advantages of double and triple action hydraulic four-column metalworking presses for versatile, low-cost, deep-metal drawing has been published by Lake Erie Machinery Corp. The bulletin includes illustrations and general specifications of presses ranging from 75 tons to 4000 tons. (Bulletin 7.13)

(20) Fork Lift Truck

A circular describing complete operating and maintenance features of its new Model "H" electric fork lift truck is available from

Lewis-Shepard Products, Inc. The six-page presentation points out how peak maneuverability has been incorporated into the Model "H" through exclusive rear-wheel drive and by recessing the mast between the load wheels. Complete specifications and dimensions of the truck are shown. (Circular 37)

(21) Transformers

Some of the research facilities for Allis-Chalmers wide line of transformers along with their design and construction features are described in a bulletin released by the company. Covered are power, unit substation, secondary network, industrial application, furnace, distribution and instrument transformers. (61B6186C)

(22) Refractories

The Ironton Fire Brick Co. has available a bulletin discussing the applications and uses of their high alumina products. The circular describes standard brick, special shapes and ramming mixes. Detailed information is given on alumina brick, and alumina ramming mix. (Bulletin 108)

(23) Pump Motors

Totally protected pump motors, from $\frac{1}{8}$ to 1000 hp, are discussed in the new four-page bulletin published by Reliance Electric and Engineering Co. Photos and easy-to-read copy explain the features of the pump motors, which are designed and manufactured for every pump in all types of industries, wherever a prime mover of fluids is required. The bulletin explains the Reliance partial motor concept for attaching the machined motor frame directly to a pump frame to form an integrated unit. (Bulletin B-2507)

(24) Stopper Heads

A brochure on the care and use of stopper heads is available from Joseph Dixon Crucible Co. Prepared by the company's crucible and refractories division, the brochure also tells about the new stopper head cartons and "palletized" containers in which Dixon stopper heads are now being shipped. Practical tips on how to eliminate stopper damage in plants, and how to store them handily, are outlined in the four-page brochure, with photo illustrations.

(25) Hydraulic Tables and Data Bulletin

A new bulletin containing hydraulic tables and other engineering data to aid hydraulic engineers and designers has been published by Hamilton Div. Baldwin-Lima-Hamilton Corp. The 40-page bulletin describes and illustrates the range of Hamilton presses for such applications as producing laminated plastics, pressing dry ice, die hobbing, preforming and plastics and metal-powder compacting. The bulletin furnishes conversion tables, decimal equivalents, hydraulic ram capacities, wire and sheet metal gages, steel pipe tables, bolt tables, specific gravities and strengths of materials. It also provides data on fluid losses, properties of metal sections, beam formulae, methods for finding moments of inertia of various sections, deflection curves for springs, temperature conversion tables and hardness conversion tables. A discussion on water hammer and shock valves and information on accumulators, pumps and intensifiers also are presented. (Bulletin No. 3500)

(26) Distribution Switchboard

A new low-voltage distribution switchboard, which accepts any combination of six different types of protective devices, is the subject of a 32-page book issued by the Distribution Assemblies Dept., General Electric Co. The new book lists features, application data, protective device information, system applications and selection, dimensions and guide-form specifications. (GEA-6627)

(27) Materials Handling Catalog

Vibratory bulk materials handling equipment and other products are discussed in a catalog published by Syntron Co. The Syntron products listed include vibrators, packers and jolters, car rappers, hopper level switches, flow control valves, feeders, screens, parts feeders, lapping and polishing machines, shaft seals, paper joggers, selenium rectifiers and rectifier units, infrared heating elements and panels, power tools and concrete finishing equipment. The catalog includes product illustrations, descriptions and specifications, as well as illustrations of many typical installations and the latest listing of Syntron sales representatives. (Catalog 5712)

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD
First Class Permit No. 1965, Sec. 34.9, P.L. & R. Pittsburgh, Pa.

IRON & STEEL ENGINEER
1010 EMPIRE BUILDING
PITTSBURGH 22, PA.

IRON & STEEL ENGINEER
Send The *free* Booklets Circled Below:

FEBRUARY, 1958

1	2	3	4	5	6	7	8	9	10	11
12	13	14	15	16	17	18	19	20	21	22
23	24	25	26	27	50	51	52	53	54	55
56	57	58	59	60	61	62	63	64	65	66
67	68	69	70	71	72	73	74	75	76	77
78	79	80	81	82	83	84	85	86	87	88
89	90	91	92	93						

NAME _____ TITLE _____
DEPARTMENT _____
COMPANY _____
CO. ADDRESS _____
CITY _____ ZONE _____ STATE _____

* INQUIRIES FOR ITEMS LISTED IN THIS ISSUE NOT VALID AFTER JUNE 1, 1958

PUBLICATIONS CURRENTLY OFFERED by Iron and Steel Engineer Advertisers

ITEM	COMPANY	BULLETIN	DESCRIPTION
50	ADALET MANUFACTURING CO., THE	BULLETIN 158	Weather-proof and explosion-proof housings
51	ATLAS CAR AND MFG. CO.	BULLETIN 1283	Transfer cars
52	AUTOMATIC TRANSPORTATION CO.		Steel and die handling equipment
53	BABCOCK & WILCOX CO., THE	BULLETIN R-2-H	Insulating firebrick
54	BABCOCK & WILCOX CO., THE	BULLETIN R-35	Castables
55	BUFFALO FORGE CO.	BULLETIN 3704	Unit heaters
56	CHEMICAL CONSTRUCTION CORP.	BULLETIN M-103	Gas scrubbers
57	CLEVELAND WORM AND GEAR CO.	BULLETIN 145	Heavy duty drives
58	CUNNINGHAM CO., M. E.	BULLETIN 613-D	Billet marker
59	CUTLER-HAMMER, INC.		Mill duty resistors
60	DELAVAL STEAM TURBINE CO.	BULLETIN 0504	Centrifugal compressors
61	DELTA-STAR ELECTRIC DIV., H. K. PORTER CO., INC.		Busway system
62	DIAMOND POWER SPECIALTY CORP.		Industrial (Wired) television
63	DURALOY CO., THE	BULLETIN 3354-G	High alloy castings
64	ELECTRIC CONTROLLER & MFG. CO., THE	BULLETIN 64	A-C crane control
65	ELECTRIC CONTROLLER & MFG. CO., THE	BULLETIN 9004 VM	Vertical master switch
66	ENTERPRISE CO., THE	BULLETIN 402	Roll-type sheet levelers
67	EUCLID ELECTRIC & MFG. CO., THE	BULLETIN 5005	Mill-type contactor
68	EXIDE INDUSTRIAL DIV., ELECTRIC STORAGE BATTERY CO., THE		Industrial truck battery
69	FELLER ENGINEERING CO.	LEAFLET 31/1e	Five-tube tester
70	GENERAL ELECTRIC CO.	GEA-6434	Front-connected d-c crane control panel
71	GENERAL ELECTRIC CO.	GEA-6643	Speed variator
72	HAUCK MANUFACTURING CO.	DATA SHEET 809	Cone gas burners
73	HILL ACME CO., THE CLEVELAND KNIFE DIV.		Metal shearing aids
74	I-T-E CIRCUIT BREAKER CO.	BULLETIN 6004-C	Switchgears
75	LARCO, INC.	BULLETIN AC-573	Crane cab and pulpit air conditioners
76	LINK-BELT CO.	DATA BOOK 2416	Belt conveyor idlers
77	LINK-BELT CO.	BOOK 2324-A	Worm gear drives
78	MASTER BUILDERS CO., THE		Grouting guide
79	PANGBORN CORP.	BULLETIN 1210	Blast cleaning and dust control equipment
80	PANNIER CORP., THE		Marking devices
81	RADIO CORP. OF AMERICA		Industrial television
82	REPUBLIC FLOW METERS CO.		Pneumatic instruments
83	ROCKWELL CO., W. S.		Valves
84	SHEFFIELD CORP., THE		Device for measuring thickness accurately without touching the material
85	SPRAYING SYSTEMS CO.	DATA SHEET 6120	Descaling nozzles
86	UNITED STATES GRAPHITE CO., THE	CATALOG B-56	Brushes
87	WAGNER ELECTRIC CORP.	BULLETIN MU-223	Motors
88	WESTERN GEAR CORP.		Mechanical power transmission products
89	WHEELABRATOR CORP.		Mechanical descaling process
90	WHEELABRATOR CORP.	BULLETIN NO. 558-D	Filtration unit
91	YODER CO., THE		Cold-roll forming
92	YODER CO., THE		Pipe and tube making
93	YODER CO., THE		Slitting

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 1963, Sec. 34.9, P. L. & R. Pittsburgh, Pa.

IRON & STEEL ENGINEER

1010 EMPIRE BUILDING

PITTSBURGH 22, PA.

IRON & STEEL ENGINEER

Send The *free* Booklets Circled Below:

FEBRUARY, 1958

1	2	3	4	5	6	7	8	9	10	11
12	13	14	15	16	17	18	19	20	21	22
23	24	25	26	27	50	51	52	53	54	55
56	57	58	59	60	61	62	63	64	65	66
67	68	69	70	71	72	73	74	75	76	77
78	79	80	81	82	83	84	85	86	87	88
89	90	91	92	93						

NAME_____ TITLE_____

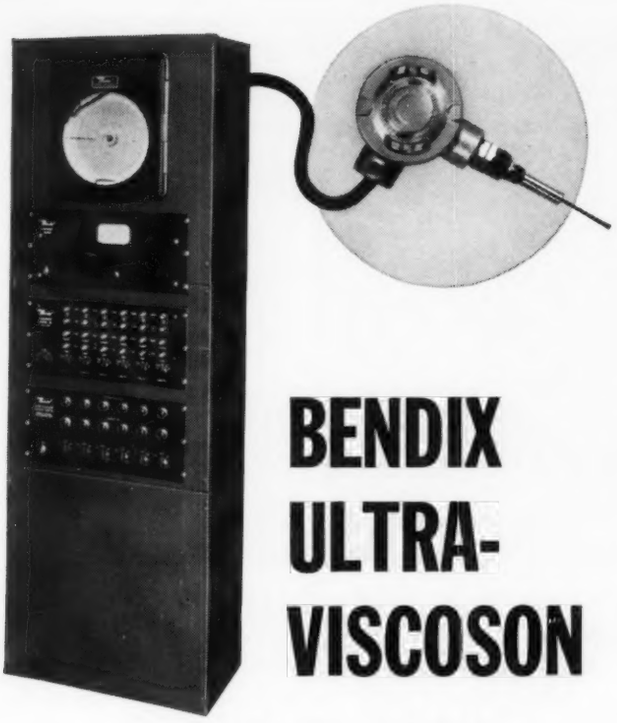
DEPARTMENT_____

COMPANY_____

CO. ADDRESS_____

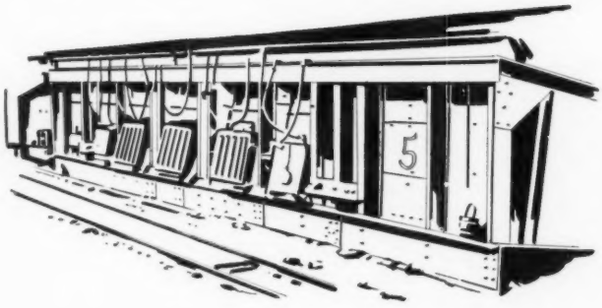
CITY_____ ZONE_____ STATE_____

* INQUIRIES FOR ITEMS LISTED IN THIS ISSUE NOT VALID AFTER JUNE 1, 1958



BENDIX ULTRA-VISCOSON

Automatically controls fuel viscosity for highest combustion efficiency



Bendix Ultra-Viscoson* can save you money by reducing heating time, furnace maintenance and fuel costs. Viscosity is a big problem in obtaining proper atomization of fuels and uniform flame characteristics for open-hearth furnaces, steam generating power plants, and glass-melt furnaces. BLOWOUTS, SPUTTERING, and POOR COMBUSTION can all result from too low or too high a viscosity.

Bendix Ultra-Viscoson eliminates these problems by automatically controlling the flow of heat exchange fluid to the pre-heater. Precise control of viscosity is maintained by continuously adjusting temperatures.

For complete information, contact the Cincinnati Division, Dept. 380, 3130 Wasson Road, Cincinnati 8, Ohio. *REG. U.S. PAT. OFF.

Export Sales: Bendix International Div., 205 E. 42nd St., New York 17, N.Y.
Canada: Computing Devices of Canada, Ltd., Box 508, Ottawa 4, Ontario

Cincinnati Division

Bendix AVIATION CORPORATION

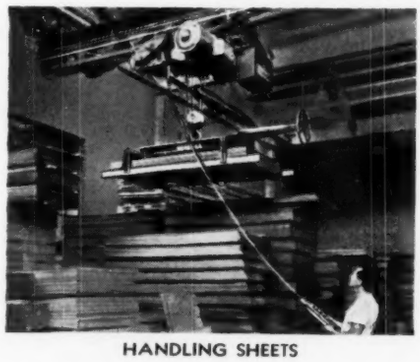
No. 1

Facts About: MANSAVER® GRABS

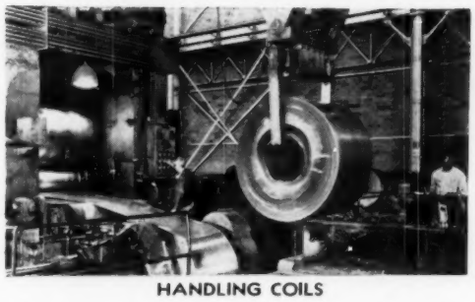
MANSAVERS are scientifically designed and engineered for YOUR INDUSTRY!

There is no need to waste money having your engineers learn an entirely new business. Let them devote their skill to the development of your own products. You will always find Mansaver a prompt source of well-designed grabs.

Mansaver grabs are now available in manual, semi- and full-automatic, and motor-operated models for lifting sheet, coils, rod, and other steel mill products. New grabs are constantly being developed. Tell us your problem.



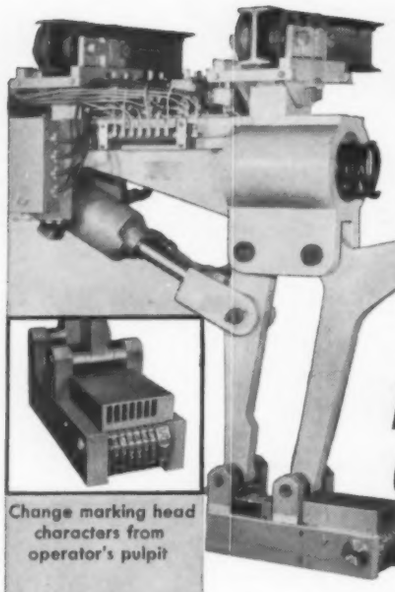
HANDLING SHEETS



HANDLING COILS

Write for names and addresses of neighboring plants where you can see Mansaver grabs in operation.

MANSAVER INDUSTRIES, INC.
3116 EAST ST., NEW HAVEN 11, CONN.
Also Manufactured in England



How to mark
BLOOMS, SLABS and BILLETS by REMOTE CONTROL

Change marking head characters from operator's pulpit

Mecco SAFETY BILLET MARKER

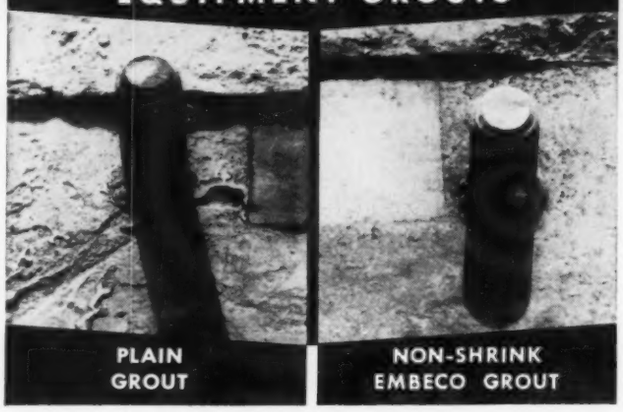
New marking head allows cut letters and ingot numbers to be changed instantly from the operator's pulpit. Wide versatility for stamping ends of blooms, slabs, and billets. *Write for Bulletin 613-D on new Billet Marker.*

A product of the Marking Device Industry

M. E. CUNNINGHAM CO.

1041 CHATEAU STREET, PITTSBURGH 33, PA.

COMPARE EQUIPMENT GROUTS



. . . And You'll See Why

EMBECO PRE-MIXED GROUT

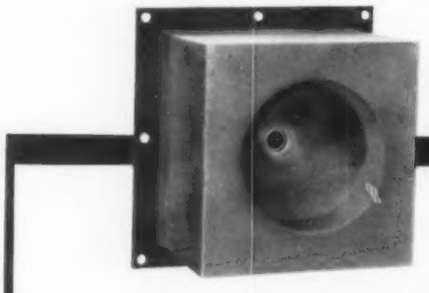
gives *lasting* results on every equipment grouting job. Add only water to Embeco Pre-Mixed Grout, mix and place. Obtain a *flowable, non-shrink* grout that insures full bedplate contact, maintains alignment, has high impact resistance.

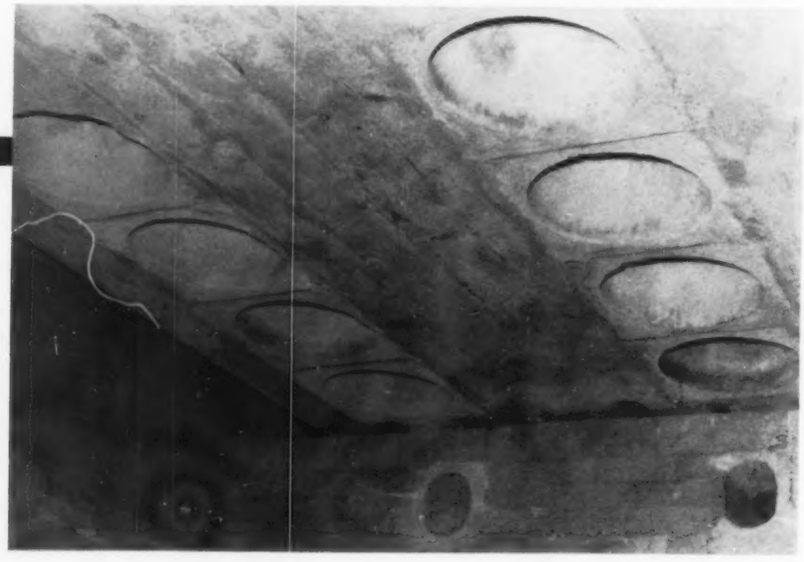
Write for Free Grouting Guide

DIVISION OF AMERICAN-MARIETTA COMPANY

the MASTER BUILDERS co.

CLEVELAND 3, OHIO TORONTO 9, ONTARIO





Flame does not touch the salt or the work . . .

with* HAUCK *"Hi-Radiant" Cone Gas Burners

This large salt bath furnace for annealing steel parts in an Eastern steel mill was designed and built by Olson Engineering Co.

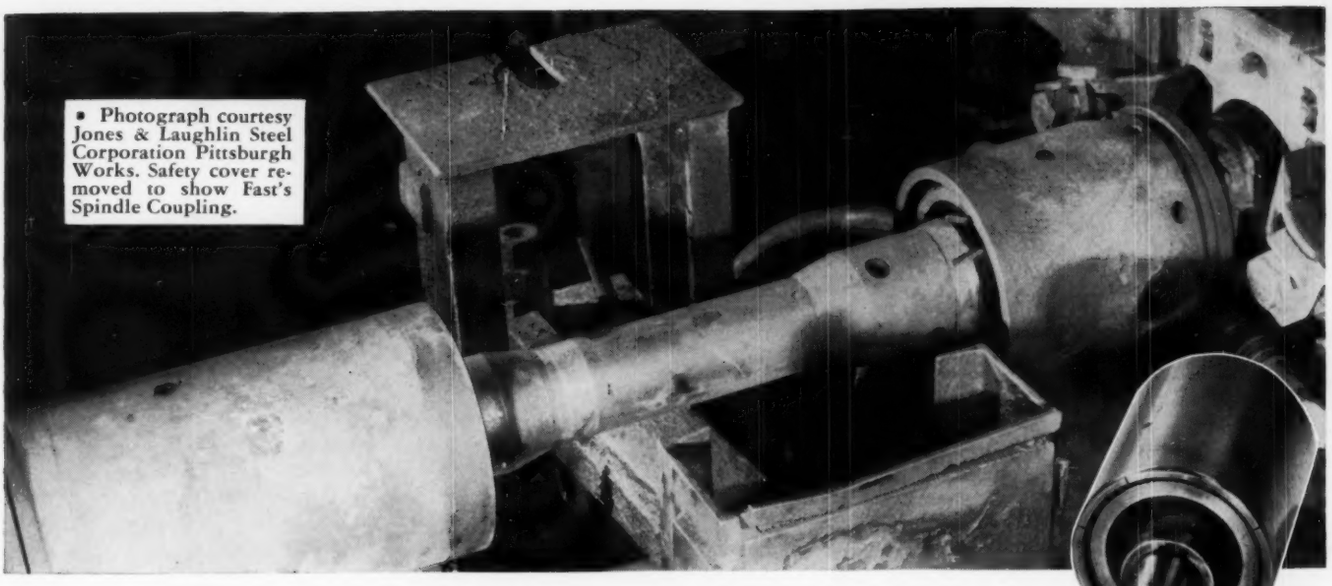
The furnace is roof-fired by Hauck Hi-Radiant Cone Gas Burners. There are observation ports at each end. Because of their short flame length, the burners can be placed closer to the salt level, providing radiant heat penetration without the flame impinging on and oxidizing the salt.

Using low pressure air and gas, these burners replaced conventional side-wall-firing burner equipment. Required gas pressure is only 6 in. W.C.

Write for Data Sheet 809. It tells how you, too, can improve heating operations in your plant.

HAUCK MANUFACTURING CO.

114-124 Tenth Street, Brooklyn 15, N. Y.



• Photograph courtesy Jones & Laughlin Steel Corporation Pittsburgh Works. Safety cover removed to show Fast's Spindle Coupling.

Fast's Spindle Couplings Mean More Profitable Rolling Mill Operations

★ *Up to 50% Less Down-Time*
★ *Quicker Disassembly*
★ *Bigger Savings on Maintenance*

The quick-disconnect and reliability features of Fast's Spindle Couplings may reduce down-time as much as 50%. Figured in dollars, this permits savings in production time in most rolling and blooming mill applications which can amount to thousands of dollars a month.

The new tooth configuration of Fast's Spindle Couplings compensates for a relatively high amount of misalignment with a minimum of backlash. It also permits constant angular velocity of the rolls which results in a marked improvement in the quality of the end product. Fast's Spindle Couplings are made of all steel construction with a metallic segmented conformable seal . . . completely self-contained and self-lubricated. They withstand the most rugged operating conditions, giving years of trouble-free service with only a minimum of maintenance.

Koppers' 38 years of experience in the coupling industry guarantees the right coupling engineered for a given application. To solve your rolling mill coupling problem write to KOPPERS COMPANY, INC., Fast's Coupling Department, 3002 Scott Street, Baltimore 3, Maryland.

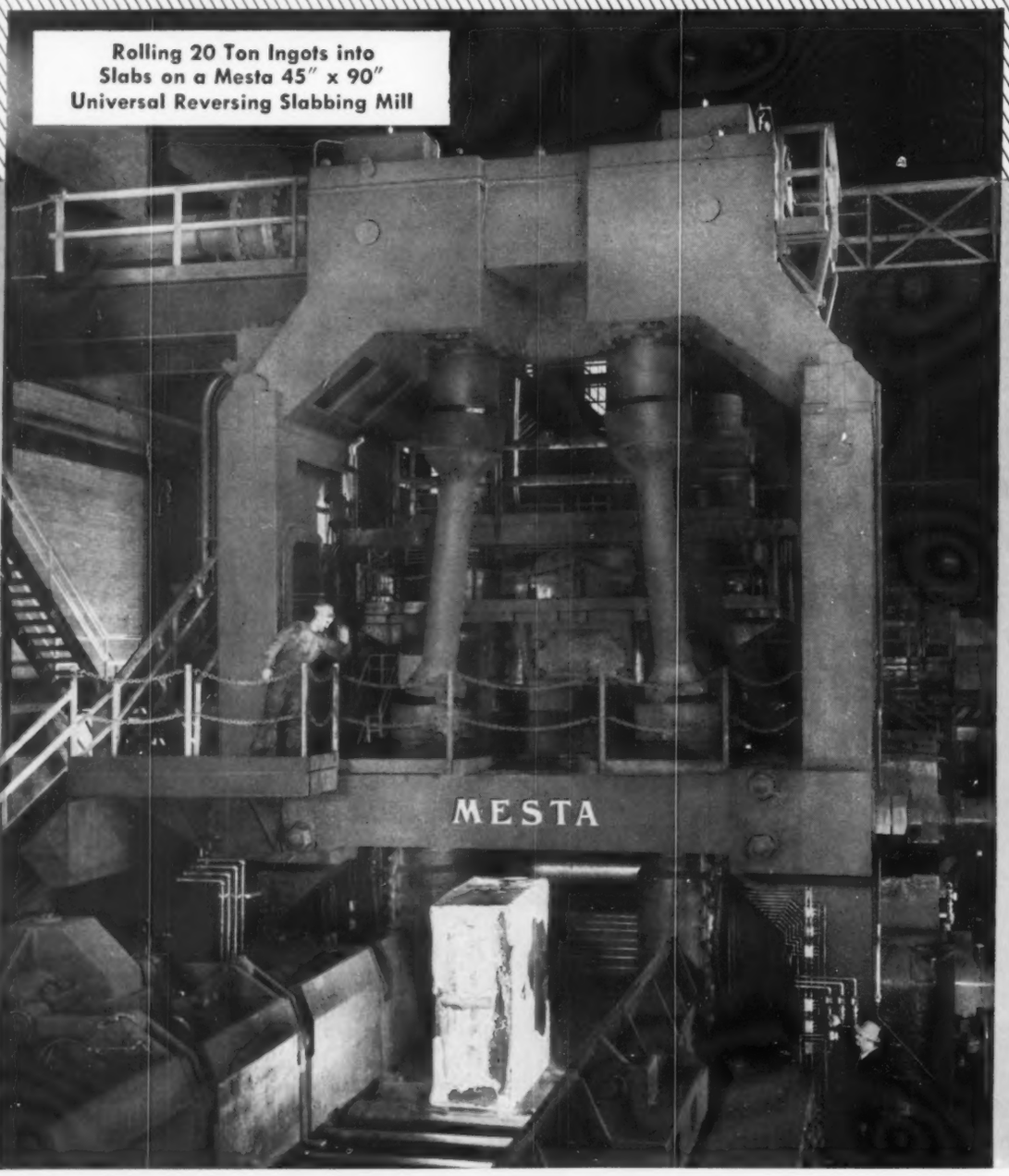
Engineered Products
Sold with *Service*

KOPPERS

THE ORIGINAL
FAST'S Couplings

SLABBING MILLS

Designed and Built by MESTA



Rolling 20 Ton Ingots into Slabs on a Mesta 45" x 90" Universal Reversing Slabbing Mill

Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA

PLANTS AT WEST HOMESTEAD AND NEW CASTLE, PA.

MESTA
THERE IS NONE BETTER

Personnel News...

S. J. Cort has retired as vice president in charge of steel operations, Bethlehem Steel Co. His successor is **E. F. Martin,** formerly general manager of the company's Lackawanna, N. Y., plant.

Mr. Cort started his career in steel at the Duquesne Works of Carnegie Steel Co. In 1916 he became superintendent of the Cambria plant of Midvale Steel and Ordnance Co., at Johnstown, Pa., now Bethlehem's Johnstown Plant. He joined Bethlehem Steel Co. the next year as superintendent of the Saucon open hearth department at Bethlehem, Pa., and in 1922 was appointed superintendent of the Saucon division. In 1928, Mr. Cort was appointed general manager of the Sparrows Point, Md., plant. He was elected vice president in charge of all steel operations in 1947, becoming a director of Bethlehem Steel Corp. the same year.

Mr. Martin's entire career has been spent with Bethlehem Steel. After holding a series of responsible positions in the Bethlehem, Pa., plant, he was transferred to Lackawanna in 1946 as assistant general manager. He became general manager in 1950.

R. H. Bahney has retired as chief engineer of Republic Steel Corp., steel plants, and **C. W. Bruce** was named to succeed him.

Mr. Bahney has worked for Republic and its predecessor companies for his entire 40-year business career. He was first employed in the electrical department of Central Steel Co. in Massillon. After the merger of Central Steel Co. and others which formed Republic Steel Corp. in 1930, Mr. Bahney became chief engineer of Republic's Central Alloy District which includes plants in Canton and Massillon. He was made assistant chief engineer of the corporation in 1941 and chief engineer in 1943.

Mr. Bruce has spent his career entirely with Republic and predecessor companies. He was first employed as a combustion engineer by Corrigan-McKinney Steel Co., which Republic acquired in 1935. In 1942 he was appointed combustion engineer of Republic's Chicago District steel plant. He was named assistant chief engineer of the Chicago plant in 1947 and chief engineer in 1949.

Donald W. Saladin has been appointed assistant general superintendent of the Fairless Works of U. S. Steel Corp.'s National Tube Division. Mr. Saladin joined U. S. Steel as an apprentice in the tool and die shop of the Lorain, Ohio, Works. In 1941, he was transferred to the Christy Park Works as a foreman and with the exception of several months at the division's National Works in McKeesport, he has spent his entire U. S. Steel career at Christy Park, where he held numerous management positions including superintendent of inspection, chief inspector and superintendent of the cylinder and heavy forge department. In April, 1955, he was promoted to the position of assistant general superintendent of the Christy Park plant —the position he held until his recent appointment.

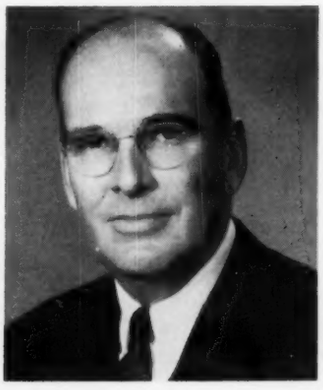
William C. Ridge has been elected vice president—production of John A. Roebling's Sons Corp. Mr. Ridge has had 15 years' experience with Roebling. Prior to his appointment, he was works manager of the corporation and before that manufacturing manager of the Electrical Wire Division. Earlier, Mr. Ridge was manager of the Standards Engineering Division.

John A. Hagan has been appointed assistant to vice president—operations of United States Steel Corp. General superintendent of U. S. Steel's Homestead District Works until his new appointment, Mr. Hagan will be concerned with short and long range planning for all mining and manufacturing facilities of the corporation on a nationwide basis. He will be succeeded at Homestead by **Robert W. Graham,** who has been serving as general superintendent at Duquesne Works. **John W. Price, Jr.,** general superintendent of Edgar Thomson Works will take Mr. Graham's place at Duquesne, while **Charles J. Fleisch,** assistant general superintendent at Homestead, will succeed Mr. Price at Edgar Thomson.

Mr. Hagan joined U. S. Steel in 1930 as industrial engineer at Homestead. Transferred to the corporation's offices in Pittsburgh in 1933, he was appointed chief industrial engineer two years later. He was named superintendent of production planning at

S. J. CORT

E. F. MARTIN



R. H. BAHNEY

C. W. BRUCE

J. A. HAGAN

R. W. GRAHAM

T. J. KOENIG

E. E. BRAYSHAW

Youngstown District Works in 1940 and returned to Pittsburgh as general manager of production planning in 1944. He was appointed assistant general superintendent at Homestead in 1950, advancing to general superintendent in 1951.

Mr. Graham was first employed by U. S. Steel at Homestead in 1925 and was appointed superintendent of the plate and slab department in 1940. He was transferred to Geneva Steel Co. in Provo, Utah, in 1943 as division superintendent in charge of rolling mills. Returning to Homestead, he was successively assistant to general superintendent and assistant general superintendent. He was named general superintendent at Duquesne in 1950.

Mr. Price joined U. S. Steel in 1937 as a metallurgical observer at Homestead. After becoming assistant chief metallurgist, he was transferred to the Pittsburgh headquarters in 1954, then returned to Homestead in 1950, as assistant to the general superintendent. He was named assistant division superintendent of the slabbing and plate division in 1952, rising to superintendent of the division in 1954. He served as assistant general superintendent at Duquesne until 1955, and was made general superintendent of Edgar Thomson Works last year.

Mr. Fleisch joined U. S. Steel in 1919 as a rodman in the civil engineering department. He served in various capacities in the civil engineering department at Homestead prior to transferring to the blast furnace division as a foreman in 1928. Advancing to assistant to general superintendent at Homestead, Mr. Fleisch then was named division superintendent of blast furnaces in the plant's Carrie Furnaces in 1945. Five years later, he was appointed assistant general superintendent at Homestead.

Theodore J. Koenig has been appointed assistant general superintendent of Homestead succeeding Mr. Fleisch. Mr. Koenig was first employed by U. S. Steel in 1926 at Gary Sheet & Tin Mill. He was successively machinist; sheet construction turn foreman; turn foreman, mechanics; maintenance shop foreman; and 80-in. hot strip mill machine shop foreman before becoming assistant superintendent of the 80-in. mill in 1942. He was made superintendent of the mill in 1946. He was transferred to Fairless Works as division superintendent of rolling in 1951, the position he held until his present appointment.

Ernest E. Brayshaw was appointed as division superintendent, rolling mills, of Keystone Steel & Wire Co. Mr. Brayshaw was formerly project engineer of Blaw-Knox Co. In his new capacity, he will be in charge of all rolling mill operations of Keystone's steelmaking facilities. After being associated with Bethlehem Steel as a roll designer, Mr. Brayshaw joined Carnegie-Illinois Steel Co. where he ultimately became superintendent of the Clairton roll department. He later became works manager of Southwest Steel Rolling Mills at Los Angeles, and in 1950 became affiliated with Continental Foundry & Machine Co.

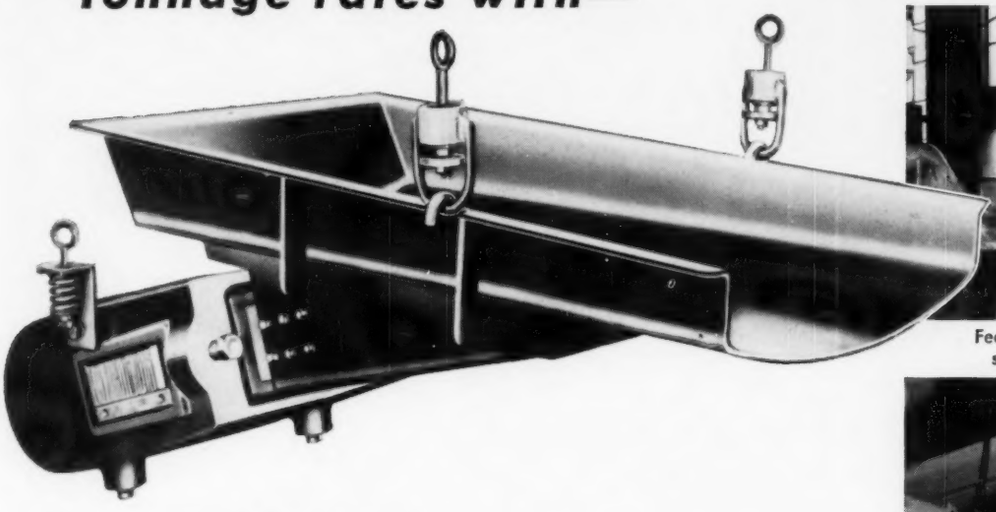
Charles W. Sherman has been appointed senior research associate for Jones & Laughlin Steel Corp. He comes to J&L from Latrobe Steel Co. where he has been director of research since 1953. From 1950 to 1953, he was process metallurgist and assistant general superintendent, respectively, at Latrobe Steel. Prior to that, he was research assistant at Massachusetts Institute of Technology. Mr. Sherman's association with the steel industry began in 1937 with Armco Steel Corp.

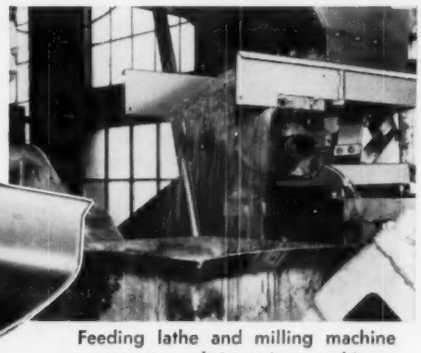
Harold E. Berg has been named chief engineer at Republic Steel Corp. South Chicago steel plant, succeeding **C. W. Bruce.** Mr. Berg began his Republic career in 1923, when he joined Interstate Iron and Steel Co., a predecessor of Republic in Chicago. After starting as a tracer and detailer in the plant's drafting department, he later was named draftsman and squad leader before his appointment to assistant chief engineer for the Chicago district in 1951.

J. Harold Taylor was appointed superintendent of blast furnaces and sintering plants, Weirton Steel Co. to succeed **A. M. Baker** who has retired. Mr. Baker came with the company in 1923 and had 34 years of service in the Operating Department. **Paul N. Neel** was named assistant superintendent succeeding Mr. Taylor.

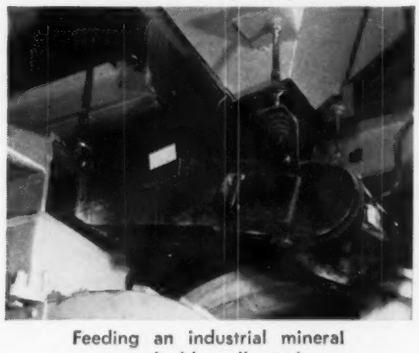
Gwilym A. Price, who has been president of Westinghouse Electric Corp. since 1946, and chairman since 1955, becomes chairman of the board in line with new executive assignments. **Mark W. Cresap, Jr.,** executive vice president and a director since 1955, was elected president, and chief administrative and operating officer. **E. V. Huggins,** who has been vice president-corporate affairs and corporate secretary, becomes chairman of the executive committee of the board of directors and vice president. **John K. Hodnette,** vice president and general manager and a director of the

Handle all bulk material efficiently at high tonnage rates with—





Feeding lathe and milling machine scrap to a briquetting machine



Feeding an industrial mineral to a double roll crusher

Feeding metal parts to a continuous heat treating furnace

SYNTRON **"Vibra-Flow"**

VIBRATORY FEEDERS

SYNTRON Vibratory Feeders combine efficiency, dependability and durability to provide controlled rate feeding of bulk materials—fine powder, coal, coke, limestone, ore, etc., hot or cold, dry or damp, to conveyor belts, screens, heat treating furnaces, dryers and other equipment.

SYNTRON Vibratory Feeders are made in a series of single electromagnetic drive models with maximum capacities ranging from 500 pounds to 1,000 tons per hour — and up to 3,000 tons per hour with multi-electromagnetic drive models. All with variable control of feed rate — for operation from 230 or 440 volt, 60 cycle a-c.

SYNTRON Vibratory Feeders can provide the dependable answer to a lot of your bulk materials handling problems. Send details to our application engineers for recommendations and quotations.

Builders of Quality Equipment for more than one third of a century

BM158

Other SYNTRON Equipment

designed to increase production, cut production costs, improve products

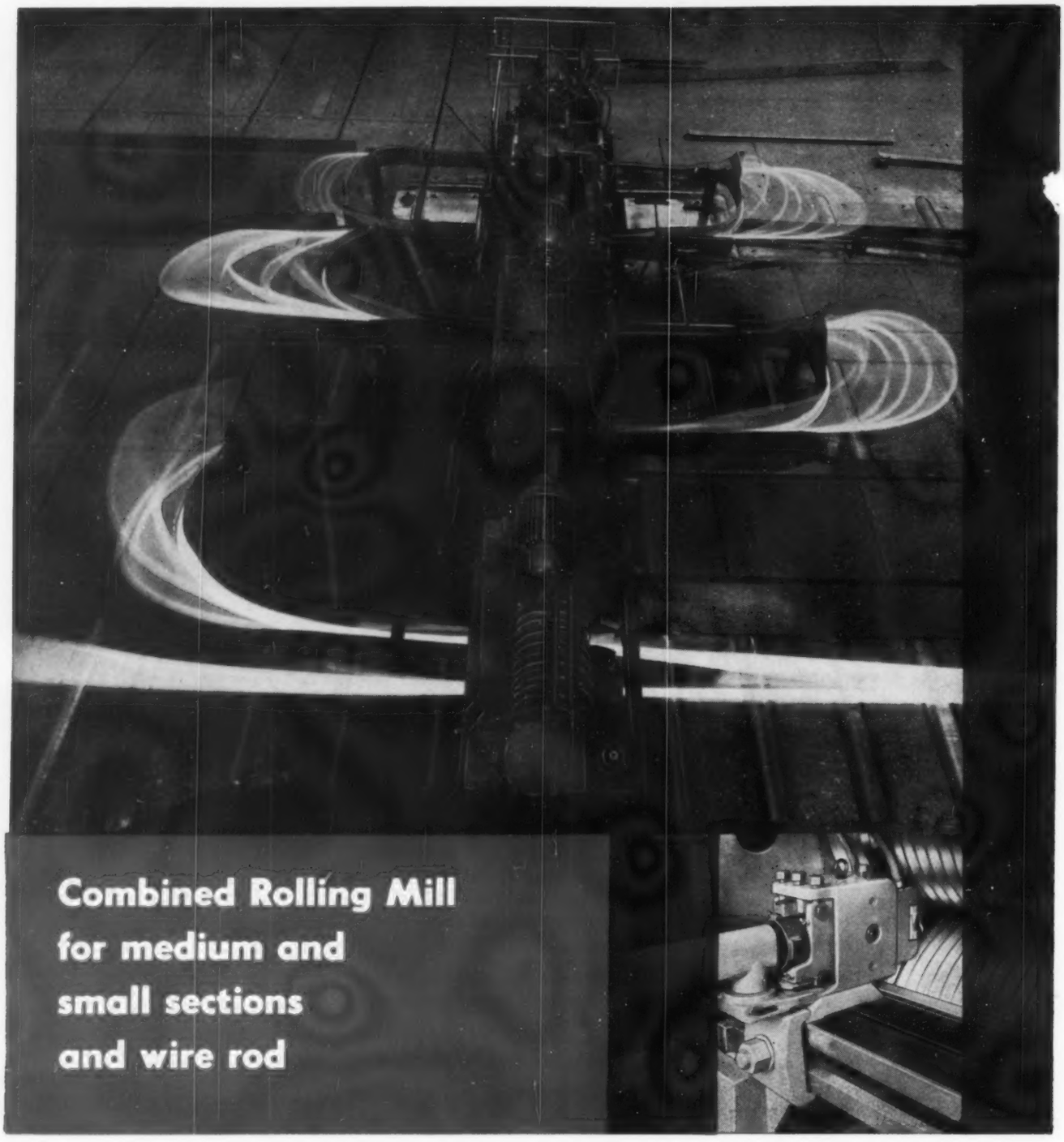
Vibrators (bins, hoppers, chutes)
Vibratory Feeders
Vibratory Screens
Shaker Conveyors
Vibratory Elevator Feeders
Weigh Feeders
Packers and Jolters
Hopper Feeders
Lapping Machines
Rectifiers (Silicon and Selenium)
a-c to d-c Selenium Rectifier Units
Electric Heating Panels
Electric Heating Elements
Sinuated Wires
Shaft Seals
Electric Hammers
Concrete Vibrators
Paper Joggers

Our representatives will be glad to work with you in selecting the proper equipment for your operation.

Call your nearest Syntron representative

Write for a SYNTRON illustrated catalog—FREE

SYNTRON COMPANY
699 Lexington Avenue Homer City, Penna.



Roller guide No. 60

Rolling with repeaters in a 19,3—21,6 in. 3-high train of MORGÅRDSHAMMARS combined medium section, small section and wire rod mill.

Our production schedule includes complete mechanical equipment for the combined rolling mill.

For further information, please apply to us for reprints from the Journal of Iron & Steel Institute.

Swedish quality

MORGÅRDSHAMMAR

MORGÅRDSHAMMARS MEK VERKSTADS AB • MORGÅRDSHAMMAR

SWEDEN

company since 1955, was elected executive vice president. Mr. Price announced the formation of a policy and finance committee consisting of the chairman of the board, the president and chairman of the executive committee. Mr. Price is chairman of the policy committee.

A. G. Delany has retired as assistant Southern district manager for Republic Steel Corp. He has spent 29 years of service at the Gadsden plant, first for Gulf States Steel Co. and then for Republic. Mr. Delany had served Republic previously as a specialist in steel plant construction. In 1950 he was "borrowed" from the Southern District and transferred to Cleveland where he directed the construction of Republic blast furnaces, open hearths, strip mills, power plants and auxiliary units.

Philip Hawkins, secretary-treasurer of Texas Steel Co., Fort Worth, since 1942, has been named president of the firm to succeed **W. A. E. Woods,** who retired January 1. Mr. Hawkins' promotion was part of a general executive reorganization program at Texas Steel. Other new officers included **B. V. Thompson,** vice president and assistant to the president; **Thurman Killman,** vice president; **M. C. Boisselier,** vice president; **E. F. Laminack,** assistant vice president; **Charles T. Ragland,** secretary and director of purchases and **Robert E. McHam,** treasurer. **George W. Armstrong, Jr.,** who served as president from 1951 to 1955 will continue as chairman of the board.

W. P. Clark has been named president of Wall Colmonoy Corp. in a recent action of the company's board of directors. At the same time, **A. F. Wall,** founder of Wall Colmonoy and former president, assumed duties as chairman of the board.

Edgar M. Herold has been appointed assistant superintendent of the roll shop, Kaiser Steel Corp., Fontana, Calif. Mr. Herold was formerly superintendent of the 10, 12 and 14-in. rolling mills at Crucible Steel, Midland, Pa. Prior to that he was with U. S. Steel. He has spent 25 years in the steel business.

Alexander Ferko was appointed manager of the Flat Products Division, Lombard Corp. Mr. Ferko began his career at Union Switch & Signal in 1925. In 1926 he moved to Jones & Laughlin, and advanced to plant layout and maintenance engineer. From 1934 to 1935 he spent a year with United Engineering in machine design. After another two years with Jones & Laughlin, he joined E. W. Bliss as machine design engineer. From 1947 to 1957, Mr. Ferko served as vice president in charge of engineering for L. W. Nash Co. In August of 1957 he joined Lombard.

Otto A. Pfaff, chairman and president of Wheelabrator Corp., has retired as president and will continue as chairman of the board. **James F. Connaughton,** executive vice president, has been elected president. Mr. Pfaff has been with Wheelabrator since 1916 and served 22 years as general manager and 17 years as president and general manager. Mr. Connaughton resigned last June as president of American LaFrance Corp. to join Wheelabrator. He is a former vice president and general manager of the Eddystone Division of Baldwin-Lima-Hamilton.

William H. Holman has been named an assistant vice president at Wheeling Steel Corp. Mr. Holman has been with Wheeling Steel since 1950. Previous to that he was associated with Jones & Laughlin Steel Corp. His first position with Wheeling was as superintendent of blast furnaces, Steubenville South Works. In 1953 he became superintendent of blast furnaces, Steubenville North and South Works. Two years later he was promoted to the position of assistant general manager, Steubenville Works. Early in 1957 he was named staff assistant in the Operations Division.

Thomas D. Clifford has been appointed superintendent of the rolling division, Fairless Works, U. S. Steel Corp., succeeding **Theodore J. Koenig,** who has been promoted to assistant general superintendent at Homestead Works. **Walter E. Banner** has been named to assume Mr. Clifford's former position of superintendent of the 45 and 80 in. mills. **John H. Hansen** was advanced to assistant superintendent of the 45 and 80 in. mills, while **John H. Hacker** was named general foreman of the 45 in. mill.

Mr. Clifford started with U. S. Steel in Gary as a rate clerk for the American Bridge Co. in 1936. Later he moved to the corporation's steelmaking facilities in Gary as a junior industrial engineer. A few years later he was transferred to the rolling division where he advanced through the various stages. By 1947, he was assistant superintendent of rolling, the position he retained until being transferred to Fairless Works in 1951.

Mr. Banner first started with U. S. Steel in 1933 as a gager in the McDonald Works in McDonald, Ohio.

E. M. HEROLD

ALEXANDER FERKO

O. A. PFAFF

J. F. CONNAUGHTON

After a short leave of absence, he returned to U. S. Steel in the same capacity at the Irvin Works. In 1938, he was appointed assistant roller and the following year, roller. He held this position until his promotion to the Fairless Works in 1951.

Mr. Hansen began his career with U. S. Steel as an engineer in Philadelphia in 1937. A year later he became a metallurgical observer at Homestead Works. In 1940 he was promoted to production engineer in the structural department. At the time of his transfer to Fairless Works in 1951, he was a general turn foreman at the Homestead Works.

Mr. Hacker's first job with U. S. Steel was that of an inspector at Homestead in 1935. He later moved to the Duquesne Works as a metallurgical observer. He stayed at Duquesne until 1944, when he was transferred to U. S. Steel's Geneva Works at Provo, Utah. He worked in numerous capacities in the Geneva rolling division and by 1948 had been appointed turn foreman of the plate and strip mill. He was transferred to the Fairless Works in 1951.

John D. Peters was named assistant to vice president —purchases of United States Steel Corp. In this newly created position Mr. Peters, formerly manager of purchasing research, will be responsible for the development of improved administrative programs and practices for application in U. S. Steel's purchasing activities. At the same time **Robert F. Benson** succeeds Mr. Peters as manager of purchasing research.

Carl Siegwarth was appointed sales manager of Lombard Corp. Mr. Siegwarth will continue to represent the corporation in a wide sales territory. After eleven years with Schloeman Engineering Co., he became associated with A. O. Smith Corp., where he served in an executive capacity for ten years.

A. C. Kohnfelder was promoted to chief engineer of the Pennsylvania Engineering Corp. He succeeds to the position held for 18 years by **Harry L. McFeaters** who was last year elected vice president of engineering. Mr. Kohnfelder joined Pennsylvania Engineering as assistant chief engineer in 1942. He was previously with Carnegie Illinois Steel Co. as plant layout engineer.

Frank J. Markey was named Chicago district sales manager, Askania Regulator Co. Mr. Markey has been manager of the control division, and will continue in this capacity.

Clement A. Mathews was named superintendent of the Cold Strip Department of Universal-Cyclops Steel Corp.'s Coshocton, Ohio, plant which is now being constructed. Mr. Mathews had been superintendent of the Wide Band Department at Bridgeville, Pa. He has been with the company 23 years.

Glenn R. Lagerstrom was appointed to assistant chief engineer and **Arthur B. Glover** to assistant to the chief engineer at Republic Steel Corp.'s South Chicago steel plant. Both men will assist **Harold E. Berg,** chief engineer at the plant.

Mr. Lagerstrom started at Republic's South Chicago plant in 1942, as a draftsman. He since has served as a blast furnace engineer and open hearth and electric furnace engineer.

Mr. Glover started at the South Chicago plant in 1956, as electrical engineer. Prior to that time, he had been electrical superintendent for Acme Steel Co. in Chicago since 1928.

Hart F. Graff, Arthur P. Kerschbaum and **Chester E. Ward** have been named senior research engineers at Armco Steel Corp. **Elbert E. Denhard** was named new senior metallurgist.

Mr. Graff joined Armco in 1947 as an analyst in the chemical laboratory. He advanced to metallurgical assistant, junior metallurgist and junior research engineer, becoming a research engineer in 1953. He is now employed in the metallic coatings group.

Mr. Kerschbaum became a senior combustion observer and fuel study man after his employment by Armco in 1940. He was transferred to the blast furnace, melting and refining group of research in 1953. He was named a research engineer in 1954.

Mr. Ward became associated with Armco in 1948 as a laboratory assistant in the magnetic laboratory. He was promoted to research engineer in 1954.

Mr. Denhard joined Rustless Iron and Steel Corp. in 1941, prior to the time the company was acquired by Armco. He advanced to junior combustion engineer and assistant metallurgist. After Armco and Rustless consolidated, he was promoted to assistant research metallurgist, becoming a metallurgist in 1954.

Alfred A. Paul has been appointed general manager of engineering-sales for The Brooks Oil Co. He has been with the company for 17 years in various capacities, including Chicago district manager and most recently manager of services.

Clinton E. Smith, until recently assistant to the general sales manager of the Pratt & Whitney Co., Inc., has been named administrative sales manager

CARL SIEGWARTH (left)

A. C. KOHNFELDER (center)

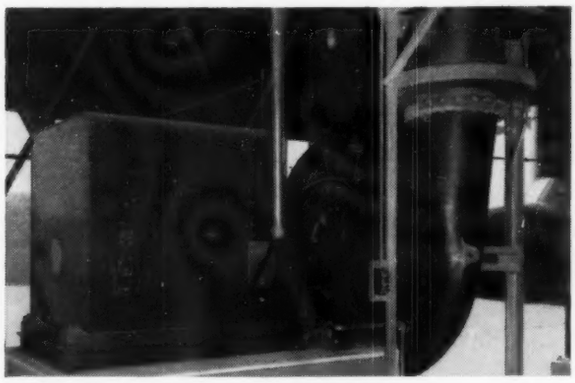
F. J. MARKEY (right)

ELLIOTT Centrifugal Compressors . . .

for flexibility in design to meet your specific needs!

MULTISTAGE, TURBINE-DRIVEN . . .

this Elliott centrifugal compressor, rated 135,500 inlet cfm, is driven by an Elliott turbine rated at 12,440 hp, at 2400 rpm.



SINGLE-STAGE, MOTOR-DRIVEN . . .

this Elliott centrifugal compressor, rated 18,000 inlet cfm, is driven by an Elliott 450-hp splash-proof induction motor at 3550 rpm.

For nearly fifty years, Elliott has been building centrifugal compressors for all applications. The standardized conservative design of Elliott compressors results in dependable service and low maintenance.

Manufacturing both turbines and motors which drive the compressors, Elliott is able to match drives to specific compressor requirements both in physical design and in performance.

Call your nearby Elliott District Office for detailed information, or write Elliott Company, Compressor Department, Jeannette, Pa.

P7-4

ELLIOTT Company

Original bearings cost 50¢ per hour of life... Bearings, Inc. recommended bearings cost less than 10¢ per hour!

The original bearings on this casting cut off machine at Intricast, Inc., Loudonville, Ohio, producers of investment castings, had a maximum life of 48 hours and their cost was approximately $24 each. The bearings recommended by our engineers cost only $17 and have now been in service for over 200 hours . . . and no indications of failure yet!

"Our most severe bearing application with speeds at 5,000 RPM and the bearings subjected to abrasive grit and casting dust," reports the Intricast Plant Manager. "Maintenance has been practically non-existent with our new bearings and the machine is much quieter," he further stated.

This is another example of our engineers' ability to solve acute bearing problems. It makes no difference where bearings are used or how many you buy . . . As authorized distributors we guarantee you factory fresh, latest type bearings ready to deliver long life and trouble free service.

Call our branch nearest you NOW!

Providing bearing service in the North →

BEARINGS, INC.

OHIO: Akron • Canton • Cincinnati • Cleveland • Columbus • Dayton • Elyria • Hamilton • Lima • Lockland • Mansfield • Toledo • Youngstown • Zanesville
INDIANA: Ft. Wayne • Indianapolis • Muncie • Terre Haute • **PENNSYLVANIA:** Erie • Johnstown • Philadelphia • Pittsburgh • York
WEST VIRGINIA: Charleston • Huntington • Parkersburg • Wheeling • **NEW JERSEY:** Camden
NEW YORK: Buffalo, Balanrol Corp. • **MARYLAND:** Baltimore • **DELAWARE:** Wilmington

and in the South →

DIXIE BEARINGS, INC.

FLORIDA: Jacksonville • **GEORGIA:** Atlanta • **KENTUCKY:** Louisville • **LOUISIANA:** Baton Rouge • New Orleans
N. CAROLINA: Charlotte • Greensboro • **S. CAROLINA:** Greenville • **TENNESSEE:** Chattanooga • Kingsport • Knoxville • Nashville

for the company's Machinery, Cutting Tool and Gage Divisions. The position is a newly created executive post established to coordinate the administration of the company's expanded sales organization that includes 21 branch offices in principal cities throughout the country.

J. V. McGuire has been appointed assistant general manager of the Pittsburgh Works of Allis-Chalmers Manufacturing Co. Mr. McGuire, manager of the switchgear department since 1955, is succeeded in that post by **D. W. Webb.**

Edward E. Kirkham, project engineer at the Pratt & Whitney Co. since 1953, has been named chief development engineer and head of the Experimental Department of the company's machinery division.

Willard H. Zinn has been named director of purchases, Wheeling Steel Corp. Mr. Zinn began his career in 1920 as a clerk in the purchasing department of La-Belle Iron Works, predecessor to Wheeling Steel, at Steubenville, Ohio. He was transferred to the general offices at Wheeling in 1921 as an assistant purchasing agent. Two years later he was made a purchasing agent. He has been assistant to the director of purchases since 1925. Mr. Zinn succeeds **Earl D. Adams** who has retired after a 60-year career in the steel industry. Starting with the American Sheet and Tin Plate Co. in 1898 and after being with the Pope Tin Plate Co. in Steubenville, Ohio, from 1901 to 1913, he became purchasing agent for Wheeling Steel and Iron Co., predecessor to Wheeling Steel, in 1913. He has directed the purchasing activities of Wheeling Steel since the company's incorporation in 1920.

A. D. Dauch has been appointed vice president in charge of foreign sales for Salem-Brosius, Inc. **W. T. Bosworth,** formerly assistant to the vice president of sales, has been named sales manager. **F. C. Frame,** formerly manager of sales mechanical products, has been named assistant sales manager.

Slade B. Gamble has joined Rust Furnace Co. as a sales engineer for specially designed furnaces. Formerly, Mr. Gamble was a process heating specialist and combustion engineer with the Lindberg Industrial Corp. Prior to the 14-year association with Lindberg, Mr. Gamble was an engineer with Frazier-Simplex for six years.

William W. Leffler has retired as superintendent of Republic Steel Corp.'s Canton, Ohio, heat-treat and bar finish departments and **Louis F. Rosing** was named as his successor. Mr. Leffler began his career with Republic in 1919, when he started in the inspection department at the Massillon steel plant. In 1944, he was promoted and transferred from Massillon to Canton as superintendent of the heat-treat and bar finish departments. Mr. Rosing, who has served as assistant superintendent of the heat-treat and bar finish departments since 1946, has been with Republic for 32 years. He started at the Canton steel plant in 1926 as an armature winder and since has served in numerous capacities in the heat-treat department including turn foreman, chief clerk and general foreman until his appointment to assistant superintendent.

Obituaries

Robert G. Cady, sales manager and treasurer of the Ajax Flexible Coupling Co. Inc., died December 12. Mr. Cady had been associated with Ajax for 27 years.

Leland K. Spink, 58, engineer in charge of flow measurement at The Foxboro Co., died December 23.

Frank B. Foster, 79, died December 28. Mr. Foster had been identified with the steel industry for over 60 years. He came to the Pittsburgh district in 1902, and in 1906 became associated, at its inception, with the Midland Steel Co., now a plant of Crucible Steel Co. of America. Later he joined Pittsburgh Iron and Steel Foundry Co., now a division of Mackintosh-Hemphill, as purchasing agent and later as sales manager. Since 1915 he has conducted his own business in the sale of new and used rolling mills and steel works equipment.

Herman F. Dobscha, a technical assistant on blast furnace operations for United States Steel Corporation, died January 14 in Provo, Utah. Born in Cleveland, Ohio, Mr. Dobscha attended Case Institute of Technology. He was subsequently associated with American Steel and Wire, National Tube, Carnegie-Illinois, Republic Steel Corp., Wheeling Steel Corp., and H. A. Brassert Co.

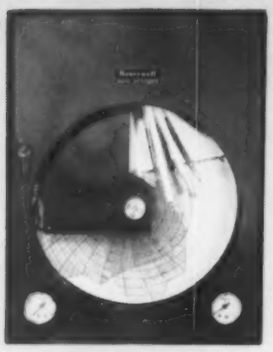
Alastair McLeod, editorial director of the metallurgical magazines of Industrial Newspapers, Ltd., London, England, died January 3.

Metal Cutting Knives *ONLY*

We offer forty years of experience in producing the highest quality Metal Cutting Knives and skilled craftsmen working with the finest materials to exacting tolerances.

A bulletin on "Metal Shearing Aids" will be sent on request.

THE HILL ACME COMPANY
CLEVELAND KNIFE DIVISION
1201 West 65th St. • Cleveland 2, Ohio



Integral Cam Programmer . . . Enables complete 1-to-24 hour program to be precast. Electric or pneumatic control on one or both pens.

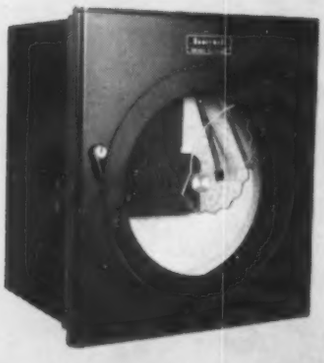
Millivoltmeter Pyrometer—Vertical Case . . . Available in a variety of electric control forms.

Flame Safeguard Relay . . . Stops flow of fuel into combustion space when flame or ignition fails.

Millivoltmeter Pyrometer—Horizontal Case . . . Fits standard relay rack for easy mounting. Also available with dual set point.

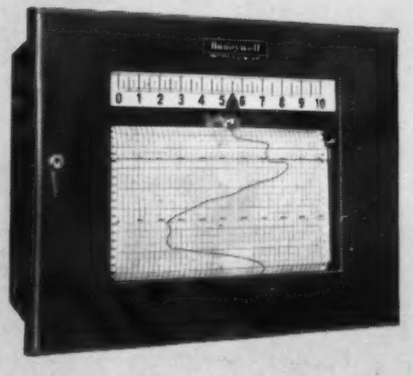
ONE

Radiation Detector . . . Responds to 98% of any temperature change within 2 seconds . . . high-speed model responds in half second. For applications from 200 to 7000F.



Circular Chart Program Controller . . . With integral cam index guide. Available with electric and pneumatic control forms.

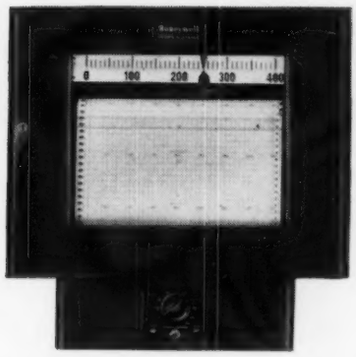
Heavy Duty Electric Motor . . . For operating valves, dampers, louvers and other final control elements.



Strip Chart Recorder—Single or Multiple Point . . . Records all types of variables. Choice of pen speeds and chart speeds.

Precision Indicator—Circular Scale . . . Highly accurate indicator for all variables, one to 48 points.

Circular Scale Controller . . . Scale is over 2½ feet long. Control index rotates with scale for 12 o'clock control check. Available in all electric control forms.



Strip Chart Program Controller . . . Incorporates temperature indication, single or multiple recording, controlling—in one instrument.

STOP shopping . . .

Whether it's temperature, pressure, flow, or any other important variable you want to measure or control, Honeywell makes just the instrumentation for you. Our line of instruments is as broad as your requirements . . . you can choose exactly what you need.

This means you get all the instrumentation you require from a single source, so there is undivided responsibility for the complete installation. And you are assured that equipment suggested for your process is recommended without bias. With a complete line there is no need to over-sell or under-equip.

For the new process, the modernization program, or a replacement problem, find out how Honeywell can go to work . . . anywhere in the metal processing industry. Get in touch with your nearby Honeywell sales engineer. He's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Precision Indicator—Vertical Scale . . . Has drum-type power-driven scale. Full scale travel in 12 or 4½ seconds.

Honeywell

H HONEYWELL

First in Controls

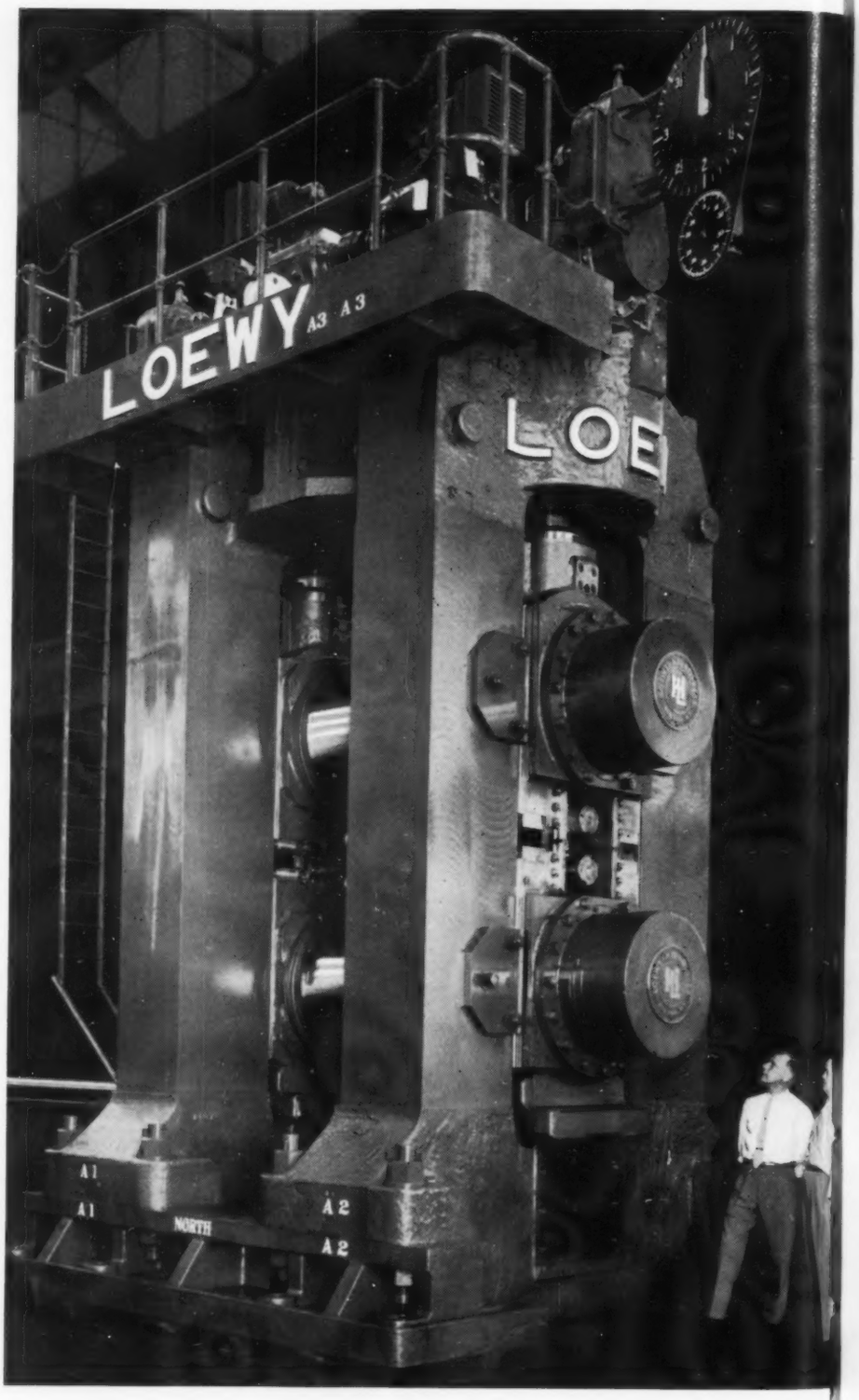
Loewy-Hydropress delivers powerful reversing mill within just 10 months of order date

Within only 10 months of the time it was given the go-ahead signal, Loewy-Hydropress has designed, built and delivered a rugged and powerful reversing mill for rolling slab ingots of particularly hard alloys.

The smooth operation and high efficiency of this unusual metal-forming installation can be attributed to Loewy's exceptional design ingenuity and wide engineering experience. But how was it possible to build it in record time, to supply it *ahead* of the promised delivery date? The answer is simple. As a division of Baldwin-Lima-Hamilton, Loewy-Hydropress has at its disposal the vast, yet smoothly integrated, resources of one of the nation's most diversified industrial organizations. B-L-H's unsurpassed facilities assure you of products that meet the most exacting quality requirements. And close coordination among all B-L-H divisions is the chief reason why Loewy-Hydropress can deliver your rolling mills faster.

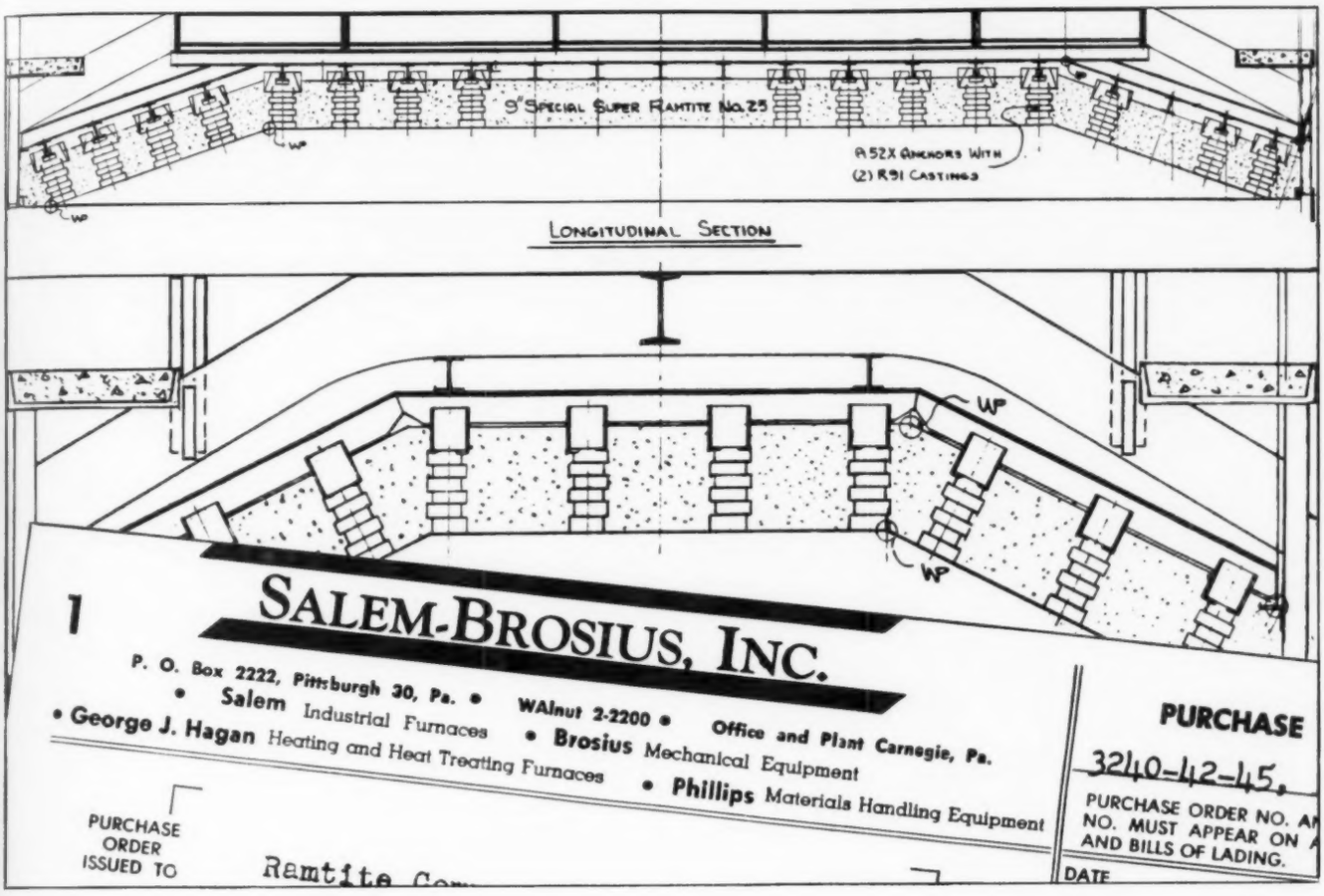
Outstanding Loewy rolling mill installations for steel and nonferrous metals are operating in this country and abroad. Loewy designs, builds and installs rolling mills for hot and cold strip, sheet, foil, plate and wire rod; blooming mills, slabbing mills, rail and structural mills, billet mills, skelp mills, merchant mills, laboratory mills, specialty mills, and auxiliary equipment.

For detailed information, write us today, Dept. C-2.



Shown here on the erection floor is a 4-high rolling mill for newly developed hard alloys which was designed and built by Loewy-Hydropress.

Loewy-Hydropress Division
BALDWIN · LIMA · HAMILTON
111 FIFTH AVENUE, NEW YORK 3, N.Y. Rolling mills • Hydraulic machinery • Industrial engineering


9" Special Super Ramtite No. 25
A 52 X Anchors With
(2) R 91 Castings
WP
Longitudinal Section
WP
WP
1
SALEM-BROSIUS, INC.
P. O. Box 2222, Pittsburgh 30, Pa. • WAlnut 2-2200 • Office and Plant Carnegie, Pa.
• Salem Industrial Furnaces • Brosius Mechanical Equipment
• George J. Hagan Heating and Heat Treating Furnaces • Phillips Materials Handling Equipment
PURCHASE
3240-42-45.
PURCHASE ORDER NO. A
NO. MUST APPEAR ON
AND BILLS OF LADING.
PURCHASE ORDER ISSUED TO
Ramtite Co
DATE

Again, Past Performance Paves the Way to NEW FURNACE Orders for Ramtite®

In soaking pit covers, as in other refractory applications, *it's performance that counts.*

And performance is the reason for Ramtite's ever growing use in both new and existing furnaces throughout the nation. It is also the reason for the above purchase order calling for Ramtite to line 13 new Salem-Brosius soaking pit covers to be installed in a steel mill.

In case after case, the combination of Ramtite's low thermal conductivity, monolithic construction and resistance to both mechanical injury and thermal shock has resulted in increased production and decreased fuel consumption—often doubling soaking pit cover life.

It's this type of performance that explains why today *there are more soaking pit covers lined with Ramtite than with all other plastic and castable refractories combined.*

The Ramtite Co. offers you a complete sales-engineering service. Experienced men are always available to study your refractory problems and consult with your Engineering, Mason and Ceramic Departments about your specific needs.

Write us today for further information.

RAMTITE IS OUR BUSINESS, NOT A SIDE LINE

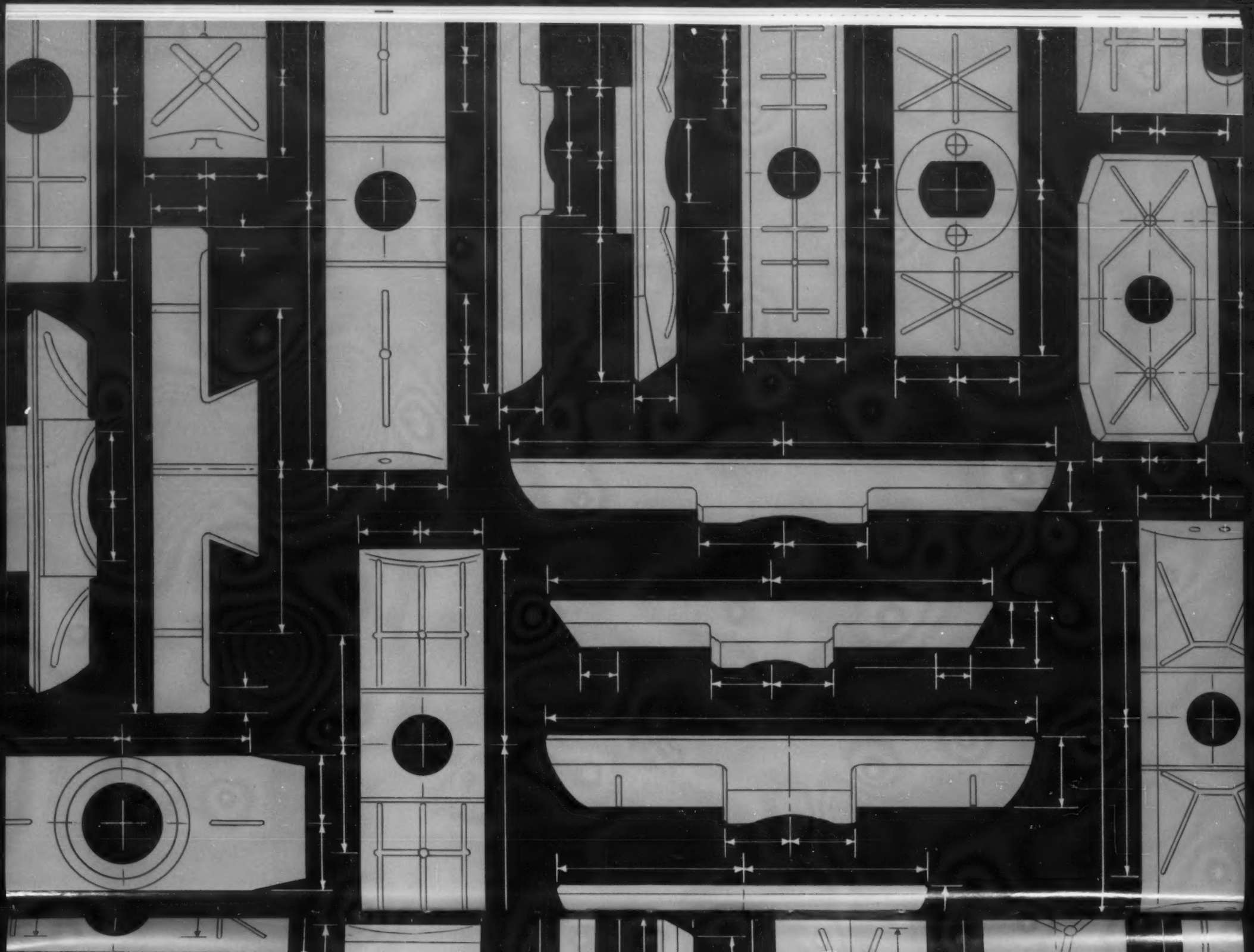
The Ramtite Co.

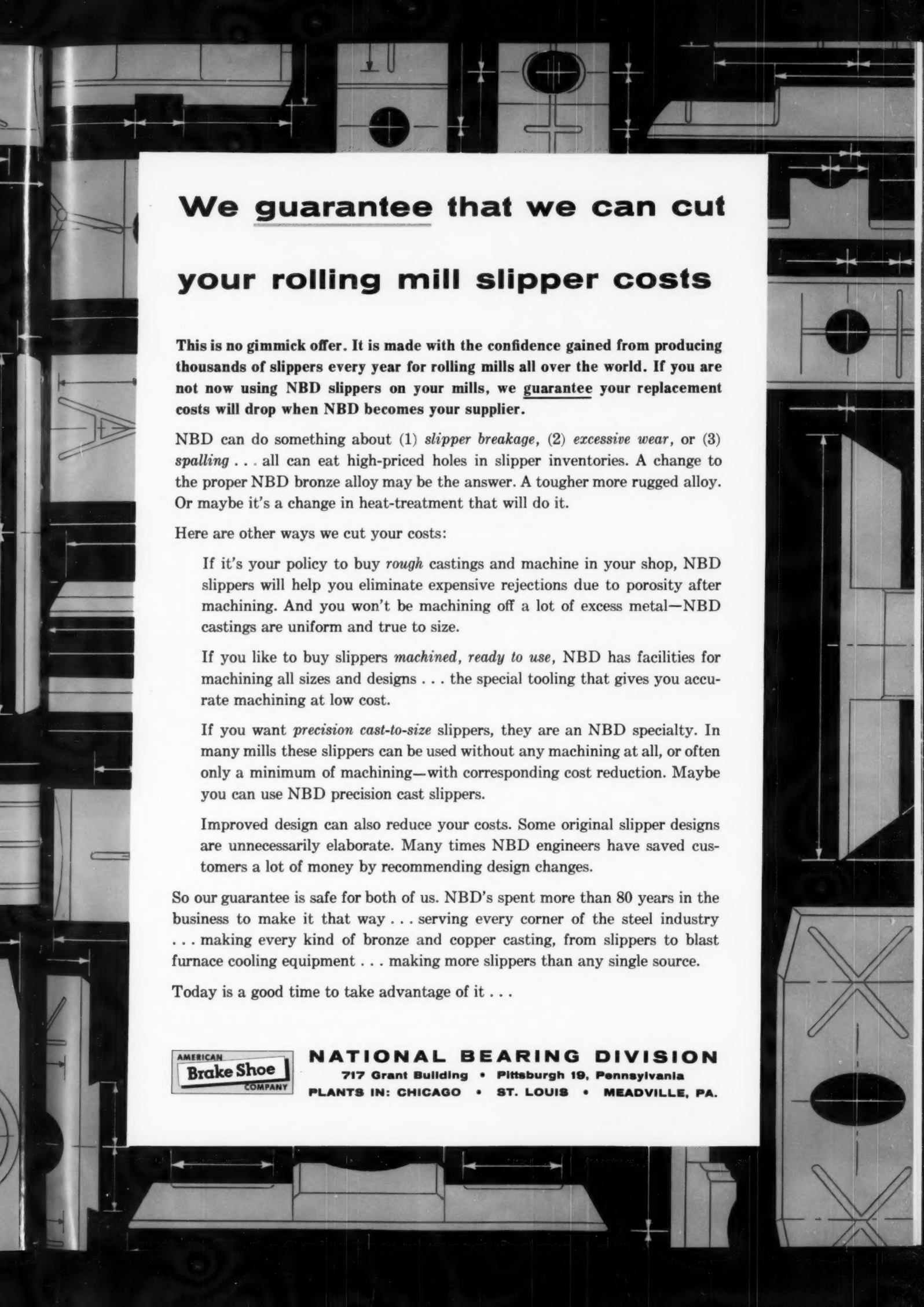
DIV. OF THE S. OBERMAYER CO.

1813 South Rockwell Street — Chicago 8, Illinois

© 1958

This is another in a series of advertisements depicting ways Ramtite Refractories serve the steel industry.





We guarantee that we can cut your rolling mill slipper costs

This is no gimmick offer. It is made with the confidence gained from producing thousands of slippers every year for rolling mills all over the world. If you are not now using NBD slippers on your mills, we guarantee your replacement costs will drop when NBD becomes your supplier.

NBD can do something about (1) *slipper breakage*, (2) *excessive wear*, or (3) *spalling* . . . all can eat high-priced holes in slipper inventories. A change to the proper NBD bronze alloy may be the answer. A tougher more rugged alloy. Or maybe it's a change in heat-treatment that will do it.

Here are other ways we cut your costs:

If it's your policy to buy *rough* castings and machine in your shop, NBD slippers will help you eliminate expensive rejections due to porosity after machining. And you won't be machining off a lot of excess metal—NBD castings are uniform and true to size.

If you like to buy slippers *machined, ready to use*, NBD has facilities for machining all sizes and designs . . . the special tooling that gives you accurate machining at low cost.

If you want *precision cast-to-size* slippers, they are an NBD specialty. In many mills these slippers can be used without any machining at all, or often only a minimum of machining—with corresponding cost reduction. Maybe you can use NBD precision cast slippers.

Improved design can also reduce your costs. Some original slipper designs are unnecessarily elaborate. Many times NBD engineers have saved customers a lot of money by recommending design changes.

So our guarantee is safe for both of us. NBD's spent more than 80 years in the business to make it that way . . . serving every corner of the steel industry . . . making every kind of bronze and copper casting, from slippers to blast furnace cooling equipment . . . making more slippers than any single source.

Today is a good time to take advantage of it . . .

AMERICAN Brake Shoe COMPANY

NATIONAL BEARING DIVISION

717 Grant Building • Pittsburgh 19, Pennsylvania

PLANTS IN: CHICAGO • ST. LOUIS • MEADVILLE, PA.

Do you think about the cost of new control circuits
WHEN YOU'RE SHAVING?

Many of your control circuit installation problems, including the cost problem, can be solved if you'll specify and use Rockbestos PNR 600 volt control cable — the cable that's been service proven over and over again through more than 14,000,000 feet of installations.

Here's why Rockbestos PNR is your best buy in control cables:

- Rockbestos PNR lets you pull a 12 conductor control cable in conduit which is now carrying ordinary six or seven conductor cable.
- With it you save on conduit and fittings, cut installation costs.
- It's 46% smaller in area — 28% smaller in diameter than conventional control cable.
- It's flexible from 167° to −67°F.
- It's light, easy to handle, pull through conduits.

Get the complete Rockbestos PNR story — write now for detailed specifications and application data.

ROCKBESTOS PRODUCTS CORPORATION

NEW HAVEN 4, CONNECTICUT

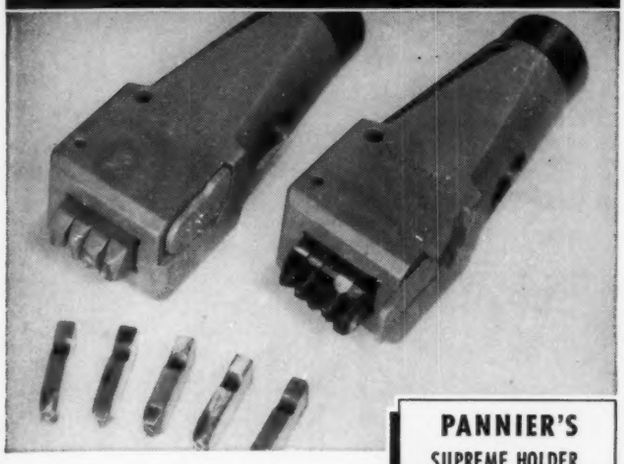
NEW YORK, CLEVELAND, CHICAGO, PITTSBURGH, LOS ANGELES, DETROIT, ST. LOUIS, ATLANTA, DALLAS, OAKLAND, SEATTLE

ROCKBESTOS

PNR
Small Diameter
Control Cable

More than 14,000,000 Feet in Service

ANOTHER *PANNIER* MASTER MARKER!



New Roto-Pin type lock is integral part of *all* Pannier Supreme Holders . . . eliminates loose, bent, dropped, or lost pins . . . flip it open to change type . . . flip it back to securely lock type in clear-marking position.

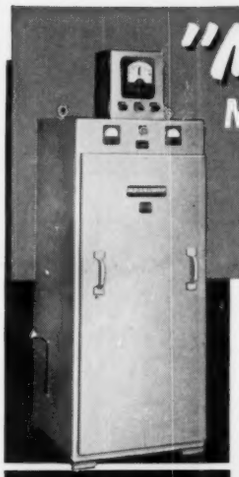
PANNIER'S
SUPREME HOLDER
WITH ROTO-PIN LOCK

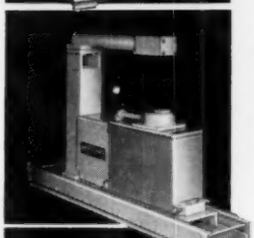
Safe, fast type changing. Holder in variety of styles.
Machined from High-Grade Bar Tool Steel. Hardened anvil maintains type alignment.
Striking Head of Tool Steel . . . Replaceable to add long service life to Holder.

Write for complete data.

BIRTHMARKED MATERIALS

MARKING MASTER PANNIER MARKERS DEVICES
THE PANNIER CORPORATION
302 Pannier Building • FAirfax 1-5185 • Pittsburgh 12, Pa.
Offices: Los Angeles • Chicago • Cleveland • Philadelphia





"MEASURAY"
MEASURES THICKNESS ACCURATELY
without TOUCHING the MATERIAL

Hot or Cold Strip Steel, Brass, Copper, Aluminum . . . Plastics, Foils, Coated Fabrics, Film, Rubber, Etc., Even When Moving At High Speed.

Simple method—the "Measuray" shoots X-Rays through the material—measures its absorption of the rays. Calibrated meter registers plus or minus per cent of deviation from pre-determined standard. Especially useful on hot mills where material can't be checked by contact gages. Also when material can be deformed by contact such as foil.

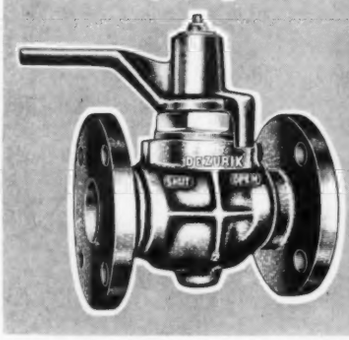
"Measuray" is accurate to 1% of thickness or less. Quickly pays for itself in reduced scrap.

Write Today for Literature to Dept. 25,
***The Sheffield Corporation,** Dayton 1, Ohio*

the **SHEFFIELD** *corporation*
of Bendix Aviation
manufacture and measurement for mankind

THIS VALVE WON'T LEAK!

HERE'S THE VALVE FOR STEEL MILL SERVICES . . . the DeZURIK PLUG VALVE!



It shuts tight . . . opens easily with ¼ turn; seals tight, despite solids in the flow, WITHOUT LUBRICATION!

DeZurik's exclusive eccentric action, in combination with resilient plug-facing, guarantees easy operation and tight shut-off with no need for lubrication!

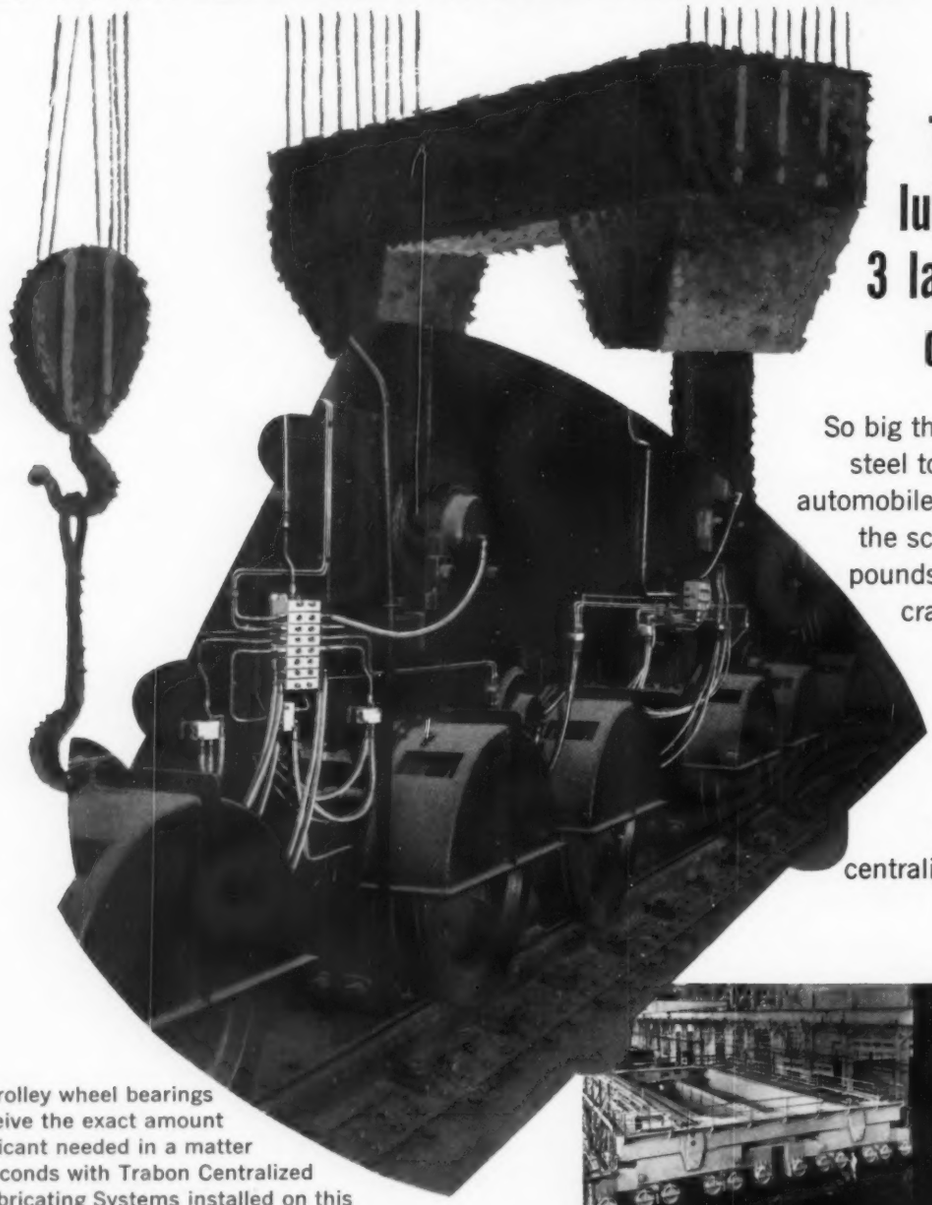
In a wide variety of applications — on oxygen lines, blast furnace gas, water, chemicals — DeZurik Valves are proving their advantages over ordinary valves in steel plants every day.

In sizes from ½" thru 20"; with manual, gear, pneumatic, hydraulic or electric operators; and in a full range of materials economically priced. Representatives in all principal cities or write for details.

DeZURIK CORPORATION
SARTELL, MINNESOTA

TRABON

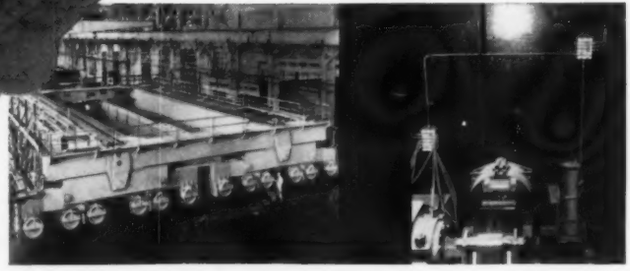
CENTRALIZED LUBRICATING SYSTEMS



Trabon lubricates world's 3 largest ladle cranes

So big they carry enough molten steel to make 750 complete automobiles. So huge they tip the scales at nearly 6 million pounds. Yes, 3 Morgan 500-ton cranes are now doing a gargantuan job at a famous Eastern steel plant. And all three cranes and their 1476 vital bearings are protected by Trabon centralized lubricating systems.

Trolley wheel bearings receive the exact amount of lubricant needed in a matter of seconds with Trabon Centralized Lubricating Systems installed on this world's largest ladle crane at an Eastern steel plant. Close up shows Trabon feeder valves which operate on the positive progression principle — most practical and foolproof method yet devised for lubricating rugged industrial equipment.



One of the three giant Morgan ladle cranes prior to being outfitted with Trabon Centralized Lubricating Systems. Note immensity of the lubricating job if it had to be done manually.

Trabon automatic lubricant pump, two feeders and lubricant lines. Note cam in right foreground which automatically starts the lubricating cycle while crane is in operation. No auxiliary machinery is necessary. Trabon is easily and economically installed on hydraulic, mechanical, electric motorized and pneumatic equipment.

Trabon

Trabon Engineering Corporation

28785 Aurora Road • Solon, Ohio

Centralized OIL AND GREASE SYSTEMS *Multifo* CIRCULATING OIL SYSTEMS

Equipment News...

PANCAKE MOTOR

Δ The Louis Allis Co. recently announced a new Pancake Motor that reduces motor length up to 60 per cent over standard motors of the same rating. It is designed for use on machine tools, roof-ventilating fans and many other space-cramped applications.

The motor is a flange type motor of conventional radial air-gap design. It achieves its short length, without any reduction in motor performance, through formed end coils and a one piece housing-bearing bracket.

For normal operating conditions it is built in an open drip-proof enclosure. Where dirt, filings, corrosive chemicals, coolants or other contaminants are present, it is furnished in an enclosed construction.

The motor is available in ratings from 1 to 15 hp at 1800, 1200 and 900 rpm. Additional features include vertical or horizontal mounting, cast iron housing-bearing bracket, modern appearance, factory lubricated bearings and quiet operation.

PORTABLE ROLL GRINDER

Δ A new concept in precision roll maintenance has been developed by the B. S. Roy & Sons Co. who have previously limited their grinding machinery to the textile field for 90 years.

Their portable traverse roll grinder can be used to redress rolls without removing them from their regular point-of-use. This feature offers the distinct advantage of not disturbing the bearing mounts of the roll.

Successful applications for the portable grinder include redressing rubber, felt, rigid plastics, thermoset plastics, nonferrous alloy, cast iron and steel rolls. Regrinding restores original roundness, straightness, contour and capacity.

An independent variable-speed motor drive permits one man operation. Rolls of any diameter—in lengths up to 100 in. can be reground to attain original efficiency. Each grinder features heavy ball bearing braces and micrometer feed controls.

OIL SEAL

Δ Recently introduced by The Garlock Packing Co. is a newly designed large sized oil seal. The new unit, designated Model 73-B, is intended for sealing applications on steel mill rolls and other large heavy duty machinery. Sizes of the seals are available to fit shafts of 8 in. to 46 in. diam.

The synthetic rubber sealing element is specially compounded to resist oils and greases, water, mild acids and alkalies. This nonporous, grainless rubber will withstand operating temperatures from −40 F to in excess of 250 F. A variety of additional compounds such as silicone rubber are available for extreme service conditions.

The Model 73-B is fitted with a steel garter spring which assures full and effective spring action at all times. Stainless steel springs can be ordered for corrosive environments. The shell to which the synthetic rubber sealing element is firmly bonded is also of steel or stainless steel as conditions may warrant.

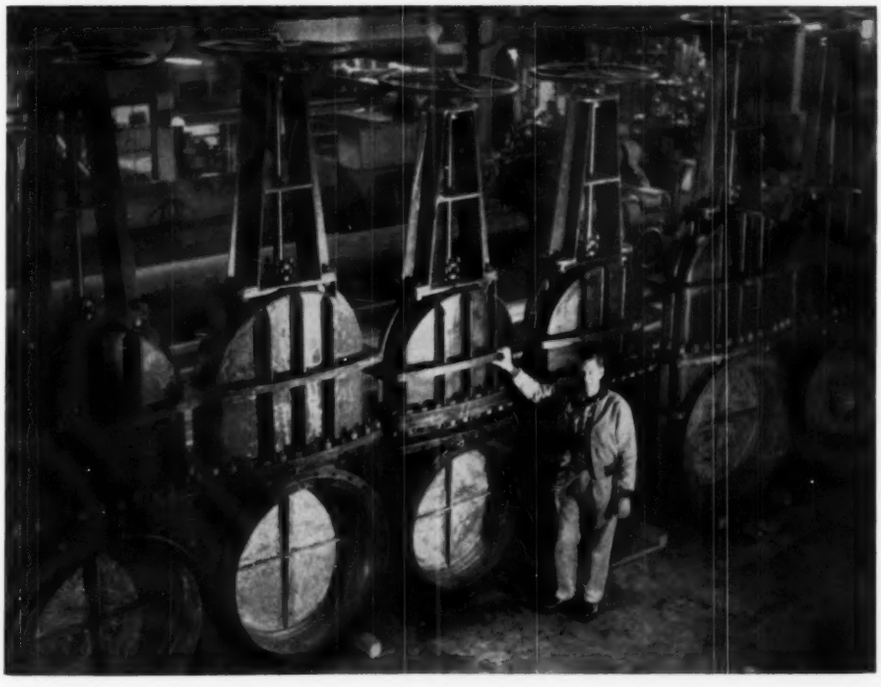
MARKER

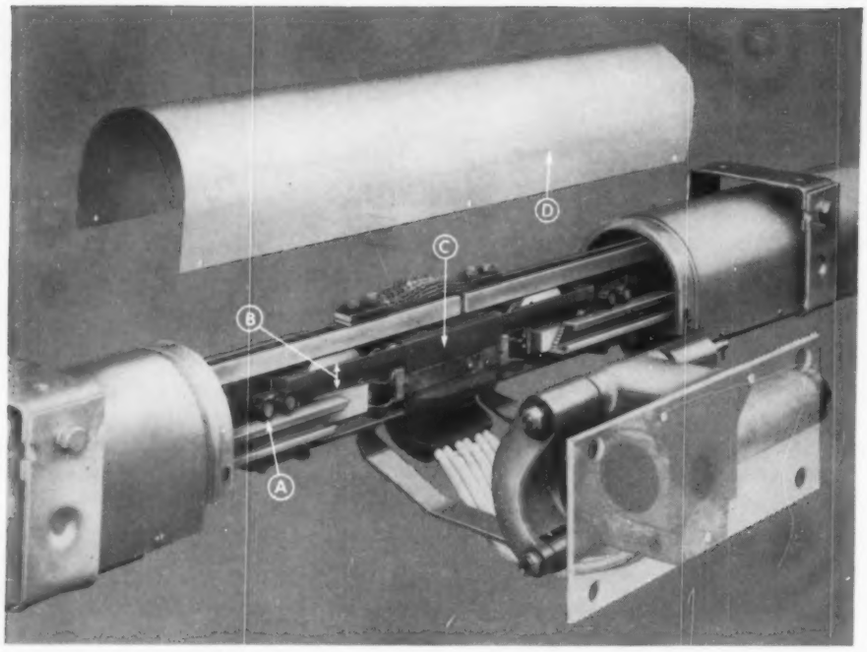
Δ A marker for any type metal whose markings withstand 2400 F is announced by the Markal Co. The "M-IO" is said to be ideal for heat-treating, normalizing, annealing and butt-weld tube marking.

The parts or surfaces to be identified are marked while cold, and the marks remain highly visible and legible regardless of the amount of heat up to 2400 F. Furthermore, they easily withstand quenchings in oil or water. One of a number of formulations for particular applications, this product contains no lead, zinc or copper pigments, and can be

SHIP "RUSH" GATE VALVE ORDER TO TATA

These 28-ft wedgegate-type valves, made by Fabri-Valve Co. of America, an affiliate of Albina Engine and Machine Works, Portland, Ore., were part of 14 such valves shipped by the company to The Tata Iron and Steel Co., Ltd., Jamshedpur, India. Fabri-Valve completed the order in 30 days, which was faster than a competing German firm could promise. The valves have openings ranging from 40 to 54 in., and were made from a German engineering firm's specifications. They will be used by Tata to control waste gases.





A. Sealed and insulated wheels. B. Long leakage distance between large special-alloy sliding contacts. C. Rugged fibreglass-reinforced molded polyester trolley conductor body. D. Removable joint covers permit easy accessibility to trolley unit.

AN OUTSTANDING SAFETY ADVANCE in supplying power to cranes

LEC-TROL-FEED®

Here is undoubtedly the finest traveling-contact equipment on the market. LEC-TROL-FEED provides the utmost in safety and dependability for the powering of cranes and other equipment traveling on straight runways, such as hoists, conveyor-belt trippers, and automatic welding units. A unique safety slot in bottom cover offers maximum protection against accidental contact with live bus bars. And your installation and maintenance costs with a LEC-TROL-FEED system are drastically lower than with ordinary trolley systems.

Rugged precision design for easy installation and minimum maintenance. Specifically engineered to eliminate the problems encountered through dirt accumulation in ordinary trolley systems. Truly the best and safest busway system you can buy. Available with bronze, aluminum, or copper bus bars, in ratings of 180, 260, and 330 amperes respectively. Standard trolley illustrated above rated 100 to 130 amperes. Higher amp. available with multiple-trolley installations.

Two men can handle 30-foot sections of LEC-TROL-FEED system with ease.

FREE BROCHURE. The full story of LEC-TROL-FEED is given in this illustrated folder. Get one from your nearest Delta-Star representative, who will supply engineering specifications based on your installation requirements and operating conditions. Or write DELTA-STAR ELECTRIC DIVISION, H. K. PORTER COMPANY, INC., 17th and Cambria Sts., Philadelphia 32, Pa. District offices in principal cities.

H. K. PORTER COMPANY, INC.

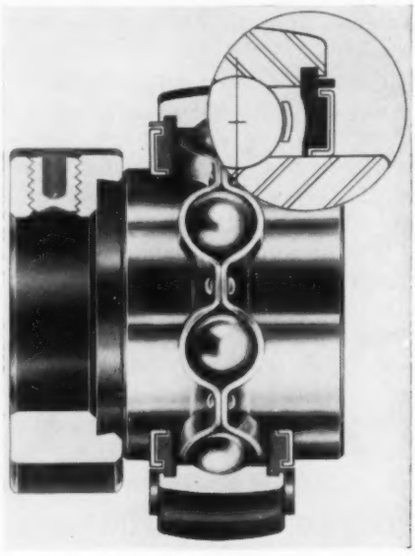
DELTA-STAR ELECTRIC DIVISION

safely used on such metals as stainless steel, titanium and zirconium. The marks can be removed if desired through use of a pickling bath.

BALL BEARINGS

△ Marlin-Rockwell Corp. announces the availability of a new series of M-R-C power transmission ball bearings for conditions involving extremes of dirt and moisture.

This series accommodates commercially ground inch shafting and may be used in standard pillow blocks. These bearings are prelubricated and equipped with M-R-C "Labri-Seals®." These seals consist of a metal flinger pressed on the ground outside diameter of the



inner ring and forming a close running labyrinth seal with the outboard face of a synthetic rubber element which is snapped into a groove in the bore of the outer ring.

The metal flinger repels dirt and moisture and protects the thin flexible lip of the synthetic rubber portion which runs on the outside diameter of the inner ring, providing a positive contact seal.

TUYERE

△ A blast furnace tuyere, using high conductivity copper in a design that affords exceptionally efficient cooling, has been developed by Bethlehem Steel Corp. and is available exclusively from Philadelphia Bronze & Brass Corp.'s Furnace Products Division.

Field testing by Bethlehem during the past four years reports that the new design, called the Eberhardt

Permanente #165 was chosen for 74 out of the last 90 rammed furnace bottoms installed in this area! Reasons: longer life, fewer repairs, less down time . . . advantages pioneered by—

For complete information,
ask for valuable installation manual "Permanente I65 and 84 Ramming Mixes for Open Hearth Furnaces."

Call or write Kaiser Chemicals Division, Dept. R-8412, Kaiser Aluminum & Chemical Sales, Inc., at any of the regional offices listed below:

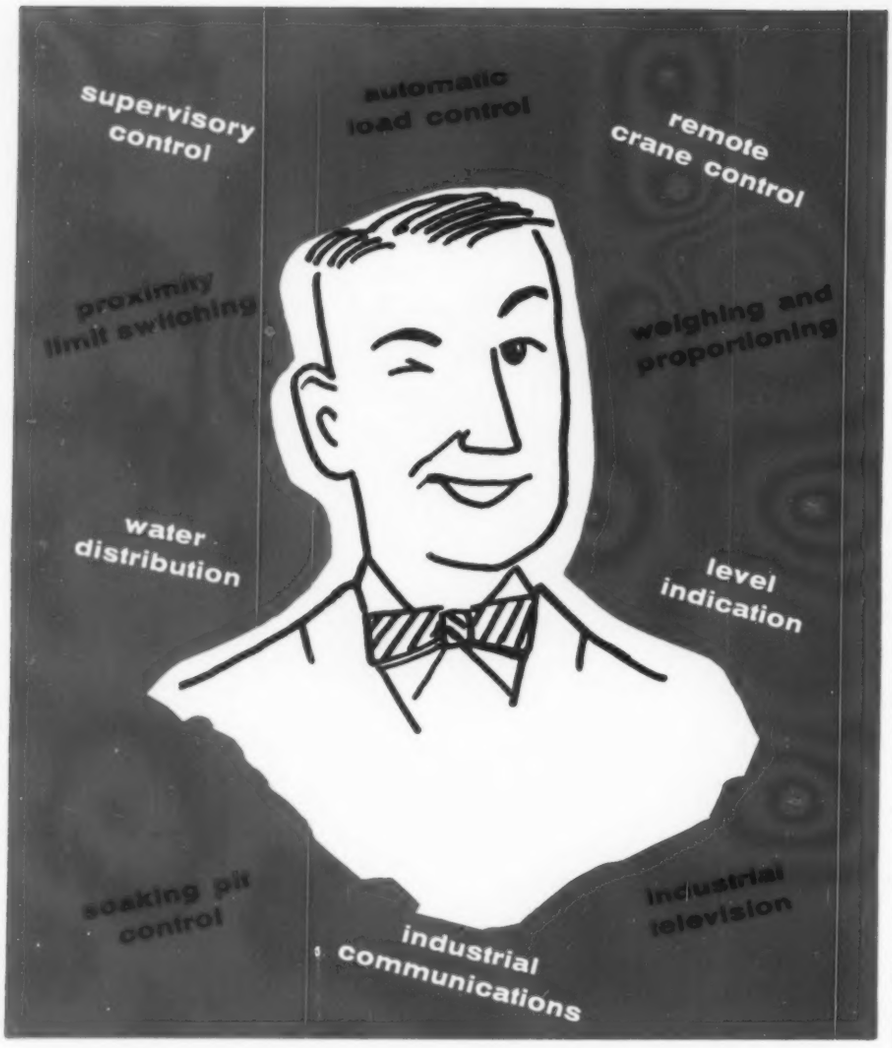
PITTSBURGH 22, PA. . . . . 3 Gateway Center
HAMMOND, IND. . . . . 518 Calumet Building
OAKLAND 12, CALIF. . . . . 1924 Broadway

KAISER CHEMICALS

PIONEERS IN MODERN BASIC REFRACTORIES

REFRACTORY BRICK AND RAMMING MATERIALS • CASTABLES & MORTARS
MAGNESITE • PERICLASE • DEADBURNED DOLOMITE • ALUMINAS

A Femco Sales Engineer is a good man to know!



With standard components, Femco provides simple, low-cost solutions of control and indication problems.

Femco engineers have developed a line of standard components, with which many different systems can be designed to provide *automatic remote control, indication, monitoring, inter-communication* or *televised observation.*

The way to find out how you can profit with a Femco system, is to get acquainted with your nearest Femco sales engineer. Phone or write for an appointment.

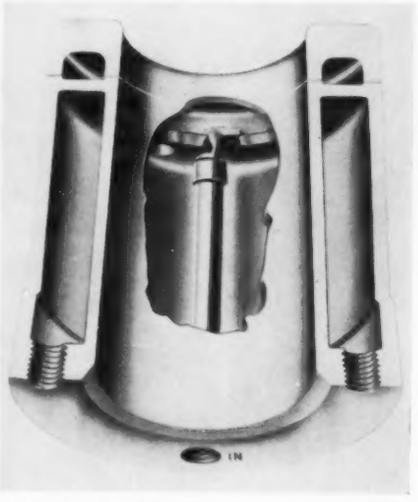
UNDERHILL 3-3200 **Femco, Inc.** IRWIN, PA.

COMMUNICATION • *Electronic Engineers* • AUTOMATION

MAKERS OF THE FAMOUS FEMCO TROLLEYPHONE

Tuyere, has five times the service life of conventional copper tuyeres. Tuyere cost per ton of iron produced has been reduced 77 per cent and iron tonnage lost due to tuyere replacement has been cut 73 per cent.

Highly efficient cooling is obtained by the use of selected materials—forged copper with 98 per cent conductivity for the nose section, and virgin electrolytic copper

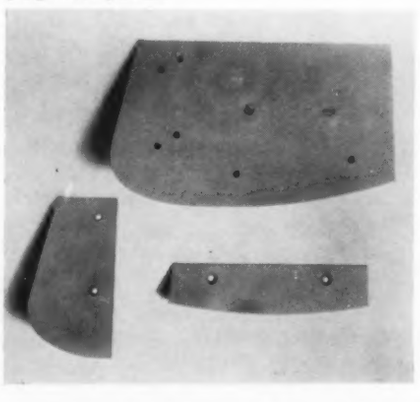


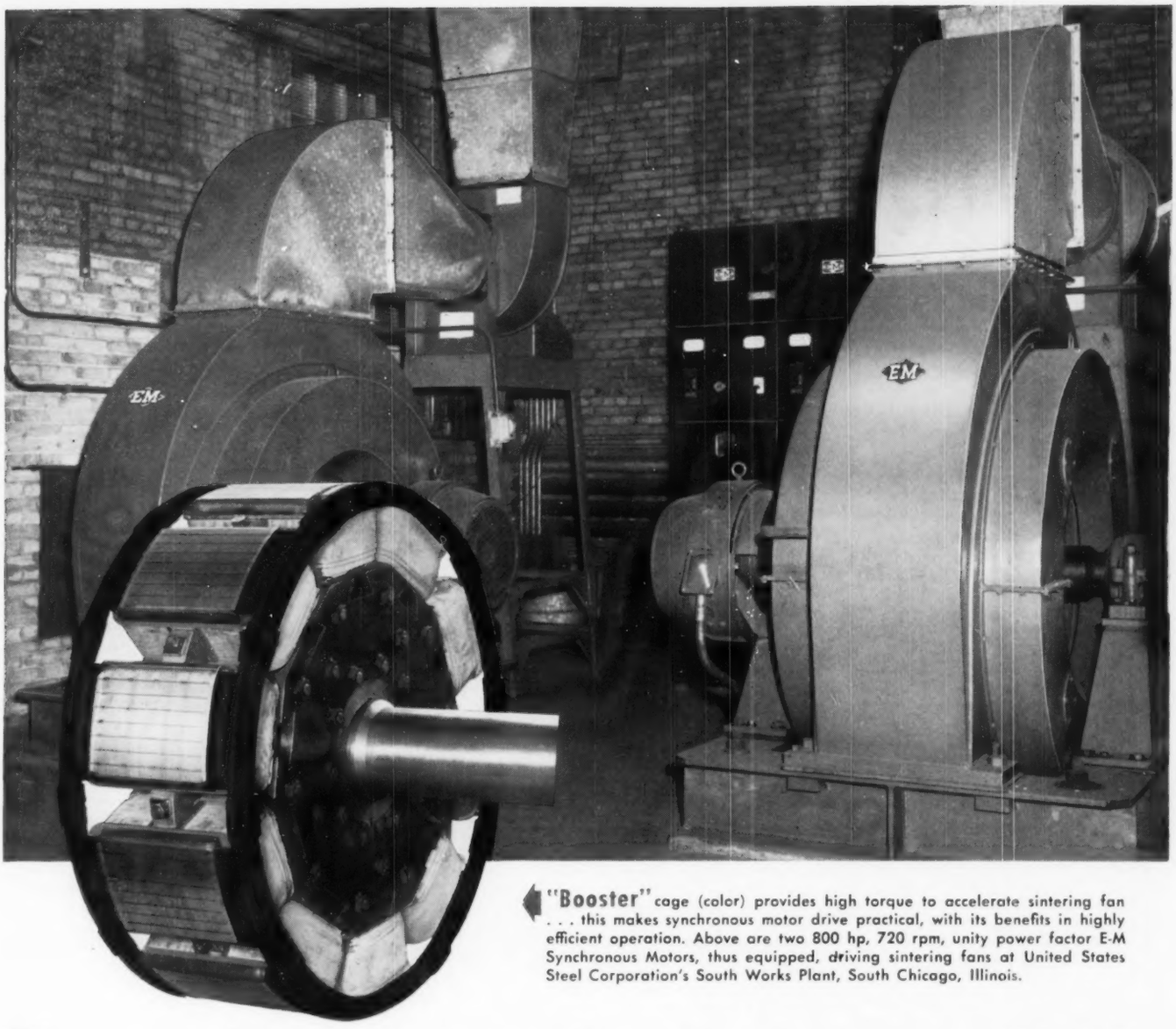
with at least 90 per cent conductivity in the tuyere body. The cooling system is designed so that water flows at maximum velocity throughout the nose section first, where heat exposure is greatest, before returning through the body.

Two-piece construction permits replacement of the nose section,

MIXER PLOW PARTS

These new wear-resistant parts are being manufactured for mixer plow assemblies by the Special Products division of Latrobe Steel Co. The large part is a steel holder for the mixer plow. The smaller parts are replaceable wear parts made of Latrobe's BR-4 steel analysis. The company says tests indicate they'll wear four to 10 times longer than standard plow and pug mill parts.





"Booster" cage (color) provides high torque to accelerate sintering fan . . . this makes synchronous motor drive practical, with its benefits in highly efficient operation. Above are two 800 hp, 720 rpm, unity power factor E-M Synchronous Motors, thus equipped, driving sintering fans at United States Steel Corporation's South Works Plant, South Chicago, Illinois.

How to drive a sintering fan most profitably

● There are sound reasons why synchronous motors (such as the installation above) are the most economical sintering fan drives. Consider your power bill . . . the high efficiency of the synchronous motor produces maximum usable horsepower from a minimum of electric power. Your entire electrical system will benefit from power factor improvement through the unique ability of synchronous motors to correct lagging power factor. You save on power costs both ways. And motor maintenance costs are low too.

However, the fans have a large WK^2, and sintering begins with a cold bed. So, E-M engineers developed a special double-deck starting cage for these difficult starting and synchronizing requirements. Here's what it does:

Characteristics of this E-M extra-heavy-duty double-cage winding are such that uniformly high torque is provided for both starting and pull-in. This E-M winding not only accelerates the heavy fan, but also provides that powerful "boost" to 98½% of synchronous speed needed to pull it into step.

Further assurance of powerful synchronizing is offered by the E-M-invented Polarized Field Frequency Control which automatically applies field excitation at the instant when rotor angle will give maximum synchronizing power with no pole slippage. Current inrush is held at a minimum.

E-M's pioneering and long experience in synchronous motor applications have resulted in many profitable steel plant installations. Ask your nearest E-M sales engineer for his practical suggestions on your requirements.

ELECTRIC MACHINERY MFG. COMPANY
Minneapolis 13, Minnesota

1100-TPA-2146

Specialists in making motors do
EXACTLY WHAT YOU WANT THEM TO

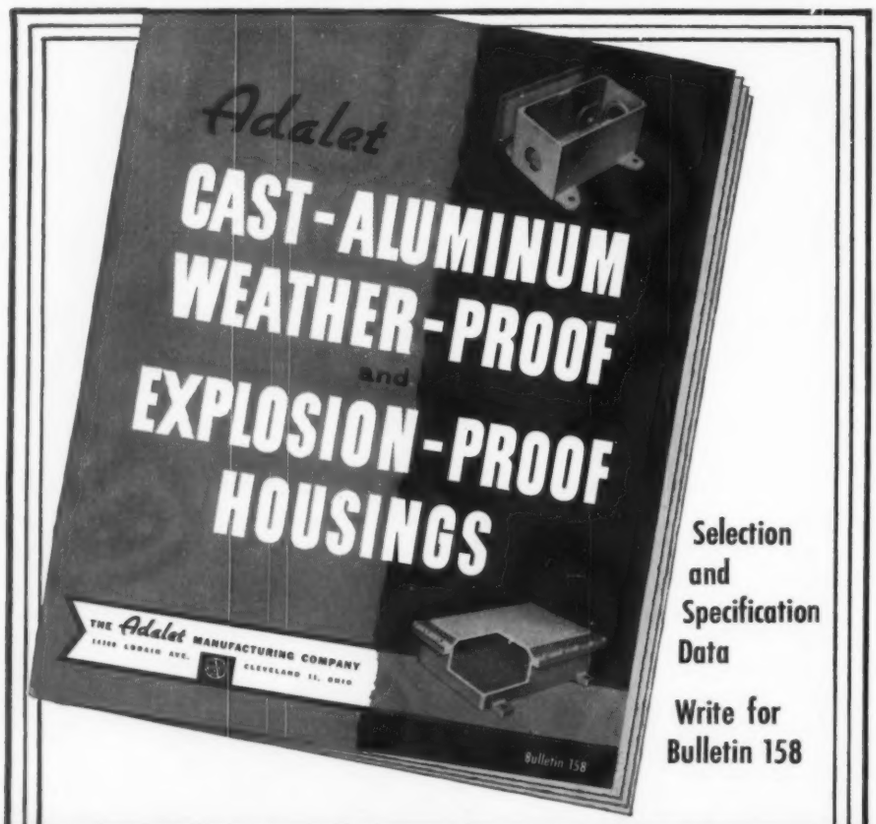
for Powdered Coal, Granular Materials, Gases containing Solids

KWIKLEEN VALVES

Not only do these valves provide full pipe flow (unobstructed by seats or bends), as well as quick shut-off, but they minimize time loss in cleaning. Accumulated solids drop into sediment chamber. Bottom end plate is quickly removed and solids drop out. No dismantling from pipe line.

Kwikleen Valves are made of any required metal in standard 4" to 16" sizes and special larger sizes; manual or mechanical operators. Write for bulletin.

W. S. ROCKWELL COMPANY
2428 ELIOT STREET • FAIRFIELD, CONN.
Sales Representatives in Principal Cities



Selection and Specification Data

Write for Bulletin 158

THE Adalet MANUFACTURING COMPANY
14300 LORAIN AVENUE • CLEVELAND 11, OHIO

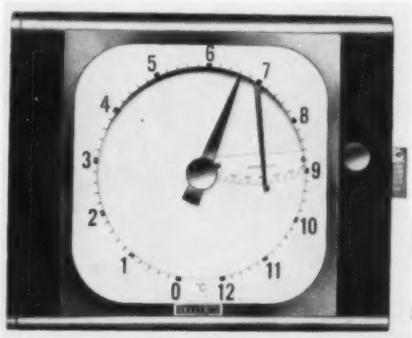
where most failures occur, without scrapping of the body.

The design is applicable to all sizes of straight and angle flow tuyeres.

POTENTIOMETER

△ A new indicating version of the Dynamaster self-balancing electronic potentiometer or bridge has just been announced by The Bristol Co.

This indicator is designed for use when legibility of the indicating scale from greater distances is an important factor. This instrument has the same 32-in. long scale and the same pointer as the standard round-chart recording Dynamaster,



and is mounted in a standard case. There is no recording mechanism, however, and the instrument indicates only.

The instrument is also offered in electric control models, in on-off, two-position, three-position, floating, proportional and current-input types of control.

The new instrument can be used for measurements of such variables as temperature, speed, pressure, smoke density, pH and electrical values.

GEARMOTORS

△ The design, manufacture and marketing of its own line of Strait-Line integral and all-motor gearmotors ranging from 1 to 60 hp and from 9 to 520 rpm is announced by Western Gear Corp.

For more than 25 years Western

THIS MAN'S A SPECIALIST IN PROTECTING YOUR PROFITS. His title is Dowell Service Engineer. His job—to study your maintenance cleaning problems, recommend the proper solutions and apply chemical solvents to help you make more profit. He represents a team of specialists who have rendered old-fashioned all other methods of cleaning product, process and steam generating equipment. His method is Dowell Service, the modern way—using solvents—to remove scale and sludge from all kinds of metal equipment, tanks, piping and lines.

Specifically: one processor had been performing his own turnaround service—using mechanical methods—at an annual cost of $315,000. The Dowell Service Engineer and his team performed the same service in 1/10 of the time at a cost of $2300. The savings in downtime alone amounted to $210,000.

If your maintenance and operating engineers do not know the profit possibilities with Dowell Service, ask them to get the facts for you. For specific information on how chemical cleaning can help your plant to greater profits, call the Dowell office nearest you. DOWELL INCORPORATED —A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY. Headquarters and research center, Tulsa, Oklahoma, with 165 offices and stations to serve you.

chemical cleaning services for industry DOWELL

Gear had manufactured the gear sections and assembled completed gear motors for a major motor producer.

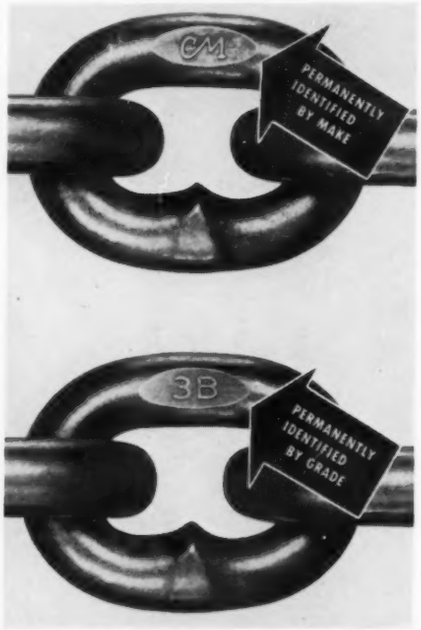
Important features of the gearmotors are interchangeability of gear sets and motor packages in the field without disconnecting the gearmotor from its foundation or the driven shaft; changing of ratio in the field, quickly and simply, when output speed variation requirements arise; easier servicing in the field because gear housings are accessible from either end; flexible inventory through the "building block" system of parts standardization; and complete reliability and uncompromising quality.

BRANDED CHAIN

△ Columbus McKinnon Chain Corp. announces the availability of permanent marks on four grades of chain.

The marks are embossed onto the links, with the make and grade marks appearing alternately at approximately 10-in. intervals along the chain opposite the weld, and on only one side of the link. This permanent branding is presently available on "Inswell" Proof Coil, BBB, High Test and Herc-Alloy chain in all sizes under ½ in.

Chain buyers can tell at a glance the day they receive chain, or



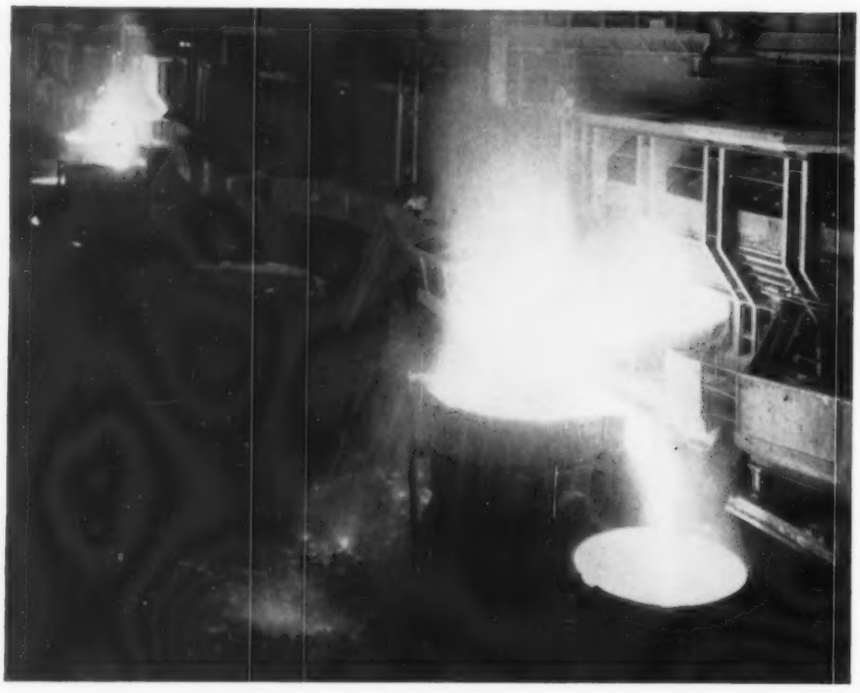
months later, the specific make of chain purchased. Chain users can be sure of the grade (strength) of the chain they are using—a definite safety advantage. Distributors can positively identify chain sold by them thereby facilitating servicing.

LATCH RELAY

△ Mechanically held latched-in relays without vertical height disadvantage have been added to the line of 10-amp control relays by the Clark Controller Co. The new Type "PML" relays are available in nine models with from two to ten poles.

Mounting dimensions are standard and parts interchangeable between Type "PM" magnetic relays and the new Type "PML" latch relays. Because the latch unit does not require increased vertical height, magnetic and latch relays may be grouped in rows as desired without waste of panel space. The latch unit occupies the space of only two poles. Since the latch unit coil is designed for continuous duty, it is not necessary to use a relay pole to cut out and protect the tripping coil.

The unique modular construction of the relays is also used for the "PML" latch relays. Poles and latch



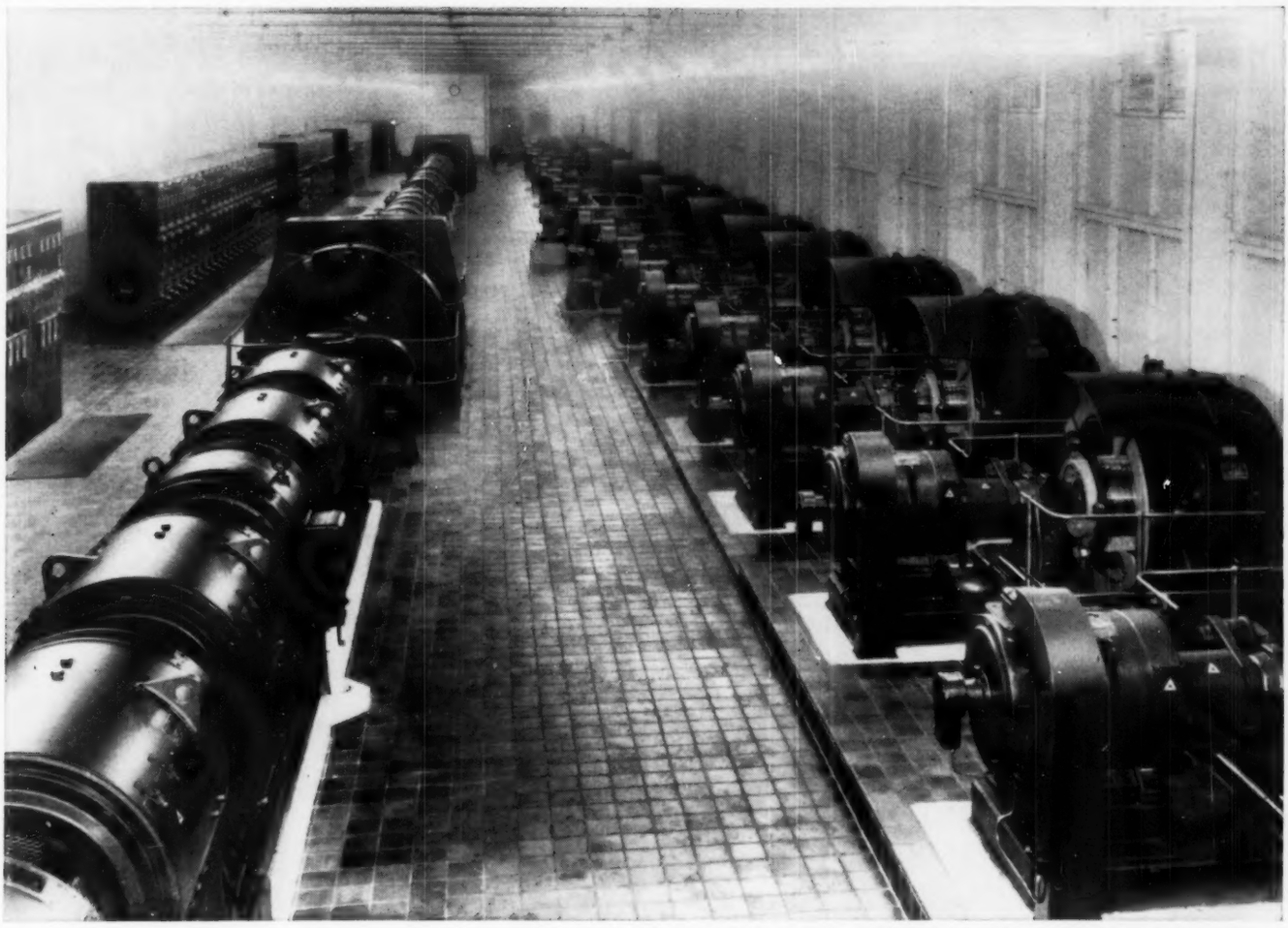
Increase production of your existing open hearths

We concur with the opinion of many steel plant operators that modernization of existing open hearth facilities represents an economical and often overlooked way to materially boost annual tonnage—with a minimum capital investment.

The required modification of present furnaces to assure a substantial increase in production involves a thorough design study—not only of hearth size or capacity, but also with respect to all other essentials of furnace structure from burners to stack. We have successfully completed a great number of such projects, and will welcome an opportunity to make a complete review of your steelmaking facilities.

From first heat to heat treat, look to **LOFTUS** *Engineering Corporation*

1 Gateway Center, Pittsburgh 22, Pa.



Photograph by courtesy of Brightside Foundry & Engineering Company Ltd.

ENGLISH ELECTRIC EQUIPS CONTINUOUS BAR MILL

This motor room for the 17 stand 11 inch continuous bar mill contains the stand drive motors totalling 8225 H.P., motor generator sets, booster sets and control gear.

The drives for the mill, flying shears, cooling beds and numerous auxiliaries, together with rectifiers and the control and distribution equipment for the high voltage and low voltage supplies, were engineered and supplied by English Electric.

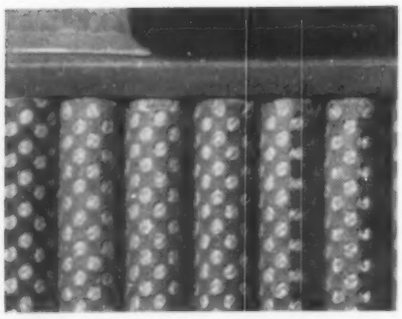
If you are planning a complete steelworks electrification, or simply the addition for a small auxiliary drive, give us a call at any district office or write direct to our Metal Industries Division in St. Catharines or The English Electric Export and Trading Company Limited, Beaver Street, New York, N. Y. Our extensive experience is at your disposal.

'ENGLISH ELECTRIC' DIRECT CURRENT DRIVES

ENGLISH ELECTRIC COMPANY OF CANADA, LIMITED, ST. CATHARINES, ONT.
VANCOUVER, EDMONTON, CALGARY, WINNIPEG, TORONTO, OTTAWA, MONTREAL AND HALIFAX

PA-5773

New Battery Unlocks More Power...Saves You Dollars



Here's the secret. Unique advanced tubular construction. Every positive plate packs more power. So you get greater battery efficiency—a more compact battery for a given capacity rating.

New Exide-Ironclad Battery packs up to 44% more power

It's today's most efficiently designed industrial truck battery. Gives you more power in the same space. More power and life per dollar of cost. Boosts the work capacity of your trucks. So you can get more work done . . . work a longer shift. For a given capacity, the new Exide-Ironclad costs you less, yet lasts longer. It's your best battery buy. Only Exide offers it. Write for detailed bulletin. Exide-Industrial Division, The Electric Storage Battery Company, Philadelphia 2, Pa.

Exide®

units are individually removable and replaceable without disturbing other poles or their wiring. All access for wiring, inspection of contacts, and removal or replacement of poles or latch unit is from the front. Because of solid side walls provided by the modular construction, no extra electrical clearance is required between adjacent relays, conserving horizontal panel space. The construction provides a solid shelf along the relay top for flat or bundled wiring, saving an inch or more of vertical height between rows of relays. Only 7/8-in. clearance is required below the relay magnet for coil change on either the "PM" or "PML" relay types.

Latch relays with up to six poles are available without double-decking. Contacts may be converted between normally-open and normally-closed in the field without extra parts. Latch unit wearing surfaces are nylon on phenolic. Contact carriers are nylon, and the linkage between contact carrier and magnet is floating so no vibration or shock is transmitted.

SHAKER CONVEYOR

△ Syntron Co. announces a new high-speed shaker conveyor that offers wide application versatility.

It can be used for high-speed conveying of most bulk materials including sand, coal, gravel, stone, grains, corrosive chemicals, clay and ores. Fitted with heated or stepped troughs, it will dry, preheat or cool materials in transit.

With screen decks, it simultaneously scalps, sizes or dewaters and conveys. The conveyor also finds application as a manual picking table.

The eccenter-driven unit, consisting of two equal length sections, is approximately 50 ft long. Two or more units may be combined to make a conveyor of any length.

FLOW TRANSMITTER

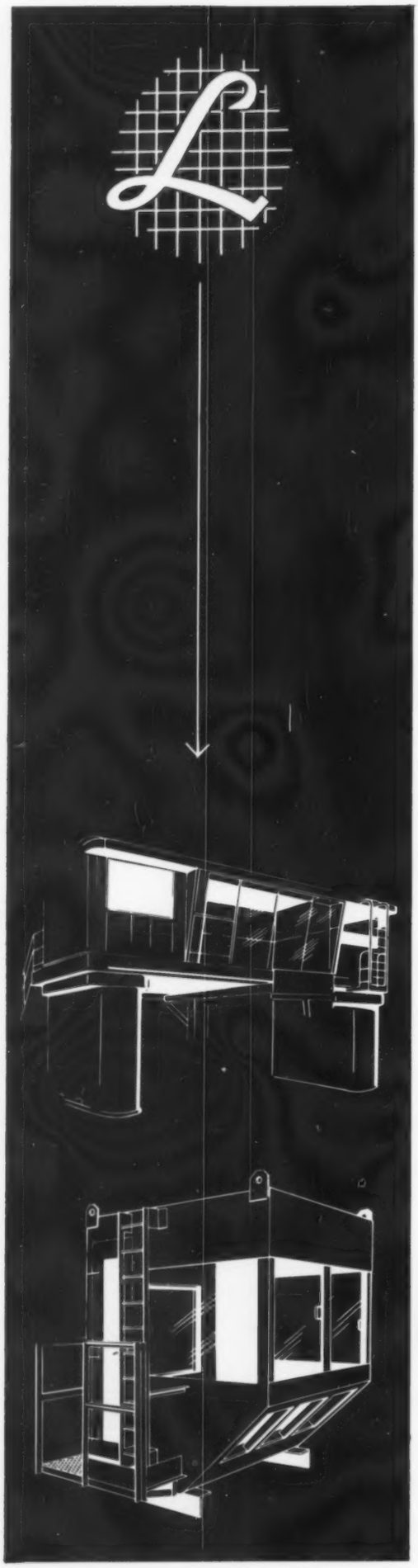
△ The Taylor Instrument Companies 205T volumetric differential pressure transmitter was designed for the purpose of simplifying difficult flow and liquid level measurements, i.e., corrosive fluids, liquids that "jell" when not in motion, colloidal suspensions and slurries. It provides a standard instrument which completely eliminates a wide variety of costly special installations and the maintenance of winterized lead lines ordinarily required between transmitter and process.

The 205T is equally effective with slurries of salt, metal or alcohol slops, with bleach, dye liquor or paper pulp solutions. Neither viscose, liquid sulphur, sulphuric or HF acid, present any added installation problems.

The entire sensing system, including the two sensing elements, their capillaries and the differential pressure sensing diaphragm to which they connect, is factory-filled with silicone compound and permanently sealed. These components are built-in, integral parts of the primary (or differential pressure sensing) portion of the 205T.

Two types of sensing unit assemblies are provided: one, for mounting flush with inside of chemical tee for pipe installation, the other, for mounting on a standard 3-in. flange. The temperature limit is 300 F at the sensing diaphragms. Pressure

SUPERIOR
CARBON
BRICK
FOR
Blast furnace linings
Blast furnace run-out troughs
Cupola linings
Steel pickling tanks
Standard sizes and shapes • Tested performances
Competent technical service • Superior chemical and metallurgical characteristics • Graphite brick also available.
May we give you a quotation?
ELECTRODE GLC DIVISION
GREAT LAKES CARBON CORPORATION
18 EAST 48TH STREET, NEW YORK 17, N.Y. • OFFICES IN PRINCIPAL CITIES



limit of the instrument is 1500 lb. And, the system is limited only by the flange rating on the primary side. The sensing elements directly contact the fluid in the pipe or tank, at two points, and relay the pressure differential to the secondary portion. Since conventional lead lines are not required, the transmitter can be mounted at ground level, with sensing elements overhead. The risk of danger to maintenance personnel is eliminated and the transmitter is free from damage or shutdown caused by corrosion, plugging, etc.

ATOMIZING NOZZLES

△ Newly-designed Spraying Systems Co. wall-mounting pneumatic atomizing nozzles, where the body acts as the flange, offer the advantages of fitting any wall thickness and easy, leakproof installation. To mount the nozzle all that is required is the drilling of one hole for entry of the nozzle cap and the drilling and tapping of four $\frac{1}{4}$-in. holes for fastening screws. When used for spraying into a pressurized chamber, a gasket between the nozzle body and wall seals the closure. Because of this design, the nozzle is suitable for any wall thickness and may be transferred and reused with later installations.

These nozzles are available in all Spraying Systems $\frac{1}{4}$J air and fluid nozzle setups—in a choice of brass or type 303 stainless steel, with rear shut-off needle, with clean-out needle assembly or with plug only.

HEAT EXCHANGER TUBE

△ A new impervious graphite tube with internal low fins that more than doubles the inner surface area of "Karbate" impervious graphite shell and tube heat exchangers has been developed by National Carbon Co., Division of Union Carbide Corp. Twenty-three fins, each $\frac{3}{16}$-in. high, increase the inner surface to 2.6 times that of a plain $\frac{7}{8}$-in. I.D. tube. The fins twist helically through the length of the tube, providing turbulent flow at right angles to their longitudinal axis, thus accentuating the difference between streamline and turbulent flow, and increasing the heat transfer coefficient as fluid velocities increase.

The increased internal surface

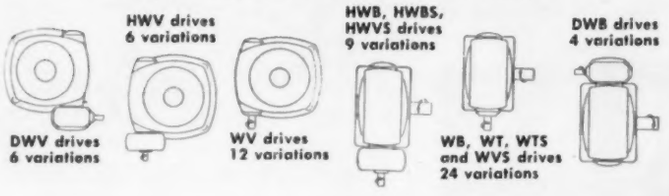
If it's a high torque/ratio drive calling for right angle takeoff . . . it's a

spot for a LINK-BELT Worm Gear Drive

Come to LINK-BELT for the best possible ratio/torque selection from industry's most comprehensive line

Name your speed reduction need. Up to 124,000 pound-inches torque . . . ratios from 3.1:1 to 8000:1 — you can meet all conditions perfectly from the broad line of Link-Belt Worm Gear Drives. Selection is simple with Book 2324-A. Ask your Link-Belt office or authorized stock-carrying distributor.

6 of 61 possible shaft arrangements using LINK-BELT Worm Gear Drives



LINK-BELT

ENCLOSED DRIVES

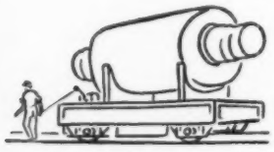
LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World. 14.683

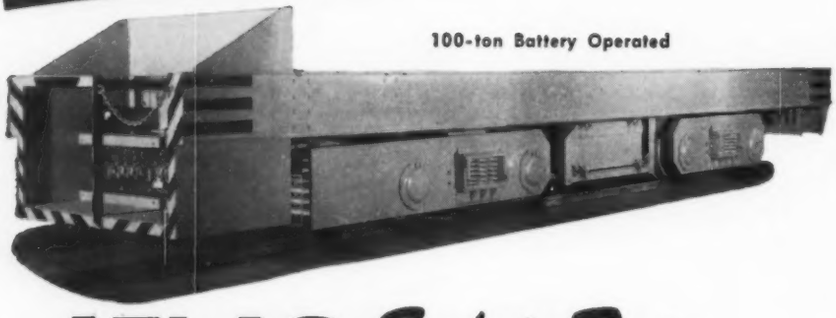
area of the new tube makes possible the design of heat exchangers with up to one-half the number of plain I.D. tubes in those corrosive services where the internal heat transfer coefficient is low and limiting. As a result, "Karbate" impervious graphite low-fin tube heat exchangers now provide excellent corrosion resistance at a cost approaching that of carbon steel, and less than that of austenitic and molybdenum stabilized austenitic stainless steel units.

The low-fin design, with its extra surface area, reduces the operating heat flux of a heat exchanger, and hence the temperature drops through the tube side fouling. This results in a longer operating cycle between cleanings, with a consequent reduction in maintenance costs.

The new low-fin tube has outer dimensions identical to 7/8-in. I.D., 1¼-in. O.D. plain impervious graphite tubes, making possible replacement of plain tubes in existing impervious graphite heat exchangers to provide greater capacity in the installation without changing flow plan, piping or support structure. The new tube is available in 6, 9, 12, 14 and 16-ft lengths.

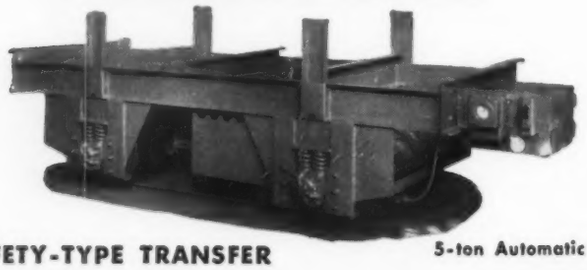
HANDLES THE BIG LOADS WITH BIG SAVINGS





100-ton Battery Operated

ATLAS *Safety Type* TRANSFERS



5-ton Automatic Controlled

ATLAS SAFETY-TYPE TRANSFER CARS can be provided in almost any capacity for storage battery, diesel or gas-electric, or cable reel service.

They are safe because there is only one control lever, and the car moves only when the operator holds the lever.

Request "Walk-Along" Bulletin 1283.

ATLAS CAR & MFG. CO.
1100 IVANHOE ROAD
CLEVELAND 10, OHIO

ENGINEERS AND MANUFACTURERS SINCE 1896

Book Reviews

"Anhaltszahlen Fur Die Warmewirtschaft In Eisenhutten Werken" (average figures for heat-economics in iron and steel works), 5th edition, 436 pages, 7 by 10 in. with numerous charts and tables, was republished by Verlag Stahleisen, Dusseldorf, Germany, in November 1957, at a price of about $13.25.

The "Anhaltszahlen" consists almost entirely of graphs and tables with only enough text to explain their use.

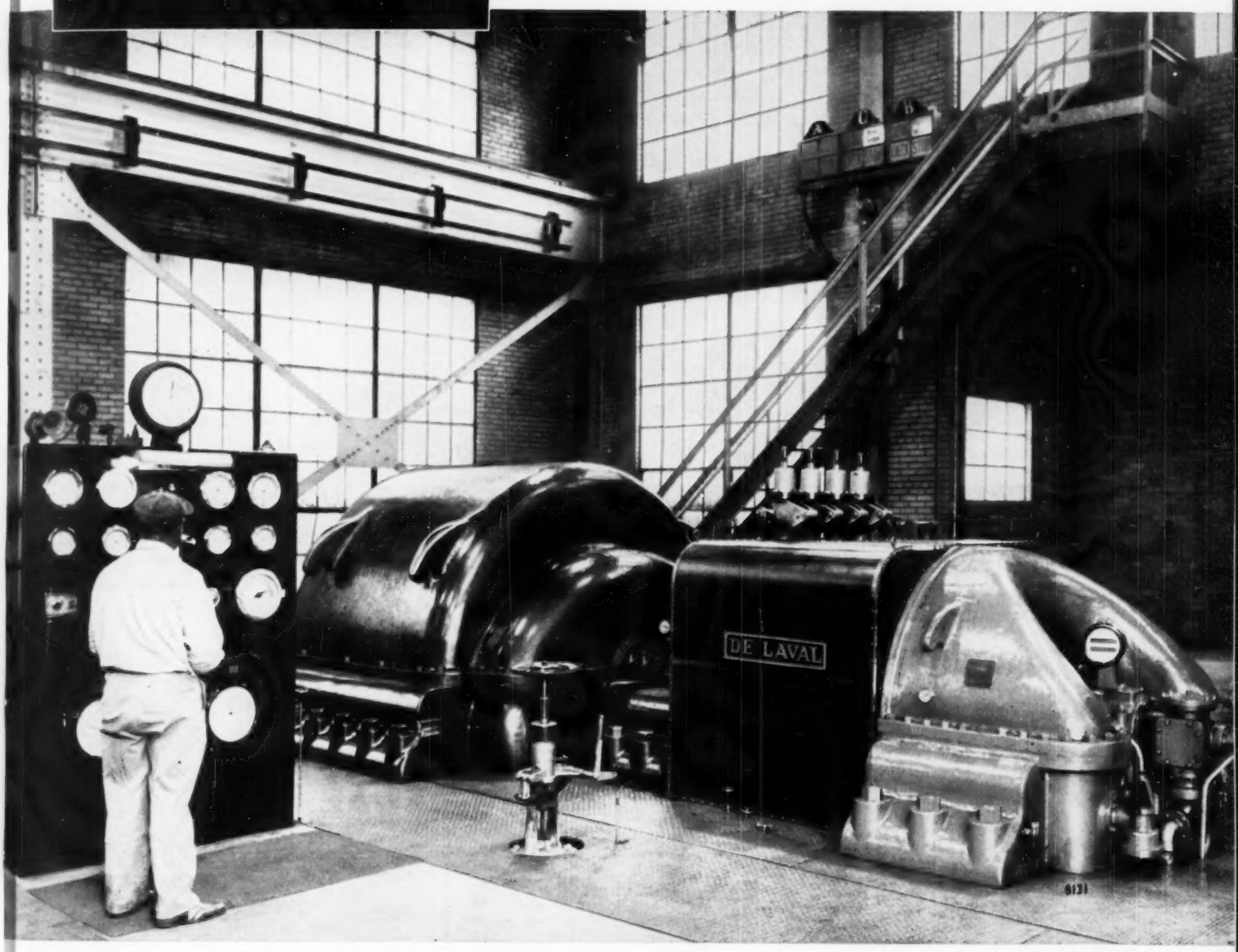
The book contains reliable, empirically proved information on heat units per ton and on kwh per ton for every phase of the production of iron and steel in an integrated steel plant, from the crushing of ore and the handling of coal, through every step, to the finished product. It also shows the relations between size and throughput for blast furnaces, open hearth furnaces, electric arc furnaces, converters and reheating furnaces. Standard dimensions (as used in Germany) are given for every piece of equipment. The book also brings data on such as consumption of heat and power in iron and steel foundries, in the cleaning of waste gases and of waste water. It even contains information of requirements of men for food and air.

It is regrettable that such useful information for conditions in the United States has not been compiled. (Reviewed by W. Trinks.)

"The Rolling of Strip, Sheet and Plate," by Eustace C. Larke, has recently been published by the MacMillan Co., 60 Fifth Avenue, New York 11, N. Y. The book contains 404 pages, 6 x 9 in., is cloth bound and sells for $12.75. The book shows how attempts have been made to apply sound scientific principles to the design and operation of rolling mills, and how these principles increased productive efficiency, decreased expensive mechanical breakdown and improved shape and dimensional qualities of the product. Roll cambers, causes and control of gage variation, factors which affect the rolling load, rolling schedules for maximum production, the calculation of the roll separating forces developed during hot and cold rolling, and how the associated energy consumed and the horsepower developed can be computed are dis-

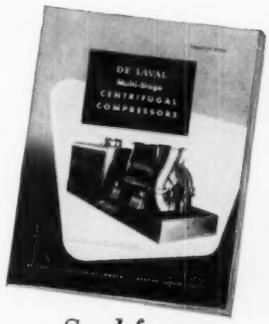
DE LAVAL
BLAST FURNACE BLOWERS

give 20 years of service at Great Lakes Steel Corp.



Shown is one of two De Laval centrifugal blast furnace blowers at the Ecorse, Michigan, plant of the Great Lakes Steel Corporation, Division of National Steel Corporation. This 85,000 cfm unit was installed twenty years ago; another 75,000 cfm unit went on the line a year earlier. Both have given dependable round-the-clock service ever since. These turbine-driven blowers are hooked up to a multi-head which enables either one to be used in conjunction with any of the three blast furnaces.

De Laval centrifugal blowers are built in single and multi-stage types to supply air in volumes up to 150,000 cfm for all classes of service in steel, gas and coke plants. The wealth of application experience acquired by De Laval over the years assures a correct and economical solution to your blower problem.



Send for Bulletin 0504

DE LAVAL *Centrifugal Blowers*

DE LAVAL STEAM TURBINE COMPANY
870 Nottingham Way, Trenton 2, New Jersey

DL-381

cussed in detail, and in fully worked-out numerical examples. A reasonably comprehensive and illustrative description of modern rolling mills including the planetary mills are contained in the book. There is an interesting and valuable chapter which relates to the productive capacity of the strip mill as affected by handling time, rolling speeds, product weight and coil length. Numerous photographs, line drawings and tables complement and illustrate the text. This is one of the best books which has come out for some years for the rolling mill operator.

"Technical Report Writing" by James W. Souther, has recently been published by John Wiley & Sons, Inc., 440 Fourtb Avenue, New York 16, N. Y. The book contains 70 pages, 8 x 10½, is bound in heavy paper and sells for $2.95. The book is an effort to present a short, concise, yet complete treatment of the fundamentals of technical writing. It is basically a design approach; the principles of engineering design, translated in terms of writing, are applied to the solution of reporting problems. The book emphasizes method and centers on the writing process; it stresses the factors the writer must consider and the processes he must follow in writing a report. The book relates report form to the use to be made of the report, and report layout becomes a design tool. If properly applied, the design approach to technical writing can prove as effective in the writing of reports as it has in the production of engineering products. Topics such as report form, the writing of abstracts, technical style and illustrations are discussed at the point in the writing process where the writer must consider them. Also included are appendices dealing with reproduction processes and sample reports.

"Heat Transfer, Volume II" by Max Jakob, has recently been published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. The book contains 652 pages, is cloth bound and sells for $15.00. The book deals mainly with selected fields of heat-transfer applications and offers a comprehensive analysis and discussion of heat radiation in spaces of simple configuration. The material is presented in three sections, Parts F, G and H. Part F (radiation) can be considered as material falling under the general organization of Volume 1, Part G, selected fields of application, and constitutes the main subject matter of this volume. Part H, supplements to Volume 1, introduces new material pertinent to the previous volume which became available after publication of the first volume. Also included are appendices covering problems, nomenclature, conversion factors, bibliography and author and subject indexes.

"Process Instruments and Controls Handbook" has recently been published by the McGraw-Hill Book Co., 330 West 42nd Street, New York 36, N. Y. The book contains approximately 1400 pages, is cloth bound and sells for $19.50. This work was prepared by a staff of specialists, with Douglas M. Considine, editor-in-chief. This book presents an organized and thorough treatment of the operating and design fundamentals of measurement and automatic control systems used in the process field; it contains a ready review of the principles of many different types of measurement and control processes, a guide to the selection of instruments and automatic controls for specific jobs, and a handy compilation of formulas, constants and critical and other engineering data for aid in solving instrumentation problems.

Allison
Abrasive Cutting Wheels

Abrasive Cutting Know-How

Know-How is just as vital to top performance in abrasive cutting as in any other machine tool operation

PROBLEM: Cut ¾" Bars of Cobalt-Base, High-Temperature Alloy at High Production Rates ... Maintain Length Tolerance with Burn-Free, Burr-Free Cuts

SOLUTION: An ALLISON Field Engineer (all are abrasive cutting specialists) prescribed the particular ALLISON wheel that met these rigid requirements.

RESULT: 576 pieces per hour, cutting 8 bars at a time as pictured above... length tolerance consistently held well within ± .015"... All cuts burn-free, burr-free!

This aircraft parts manufacturer had been unable to hold length tolerance in cutting these high-temperature alloy blanks for forging jet engine blades until he availed himself of ALLISON Abrasive Cutting Know-How and used the prescribed ALLISON wheel.

Allison Recommendations Pay Off, whether you cut titanium, stainless steel or other high temperature metals. ALLISON Abrasive Cutting gives you Fast, Economical, Quality Cuts.

ALLISON *wheels are available in a tremendous range of formulations—rubber or resinoid bonds—3" to 34" diameters—.006" to 3/16" thick—*

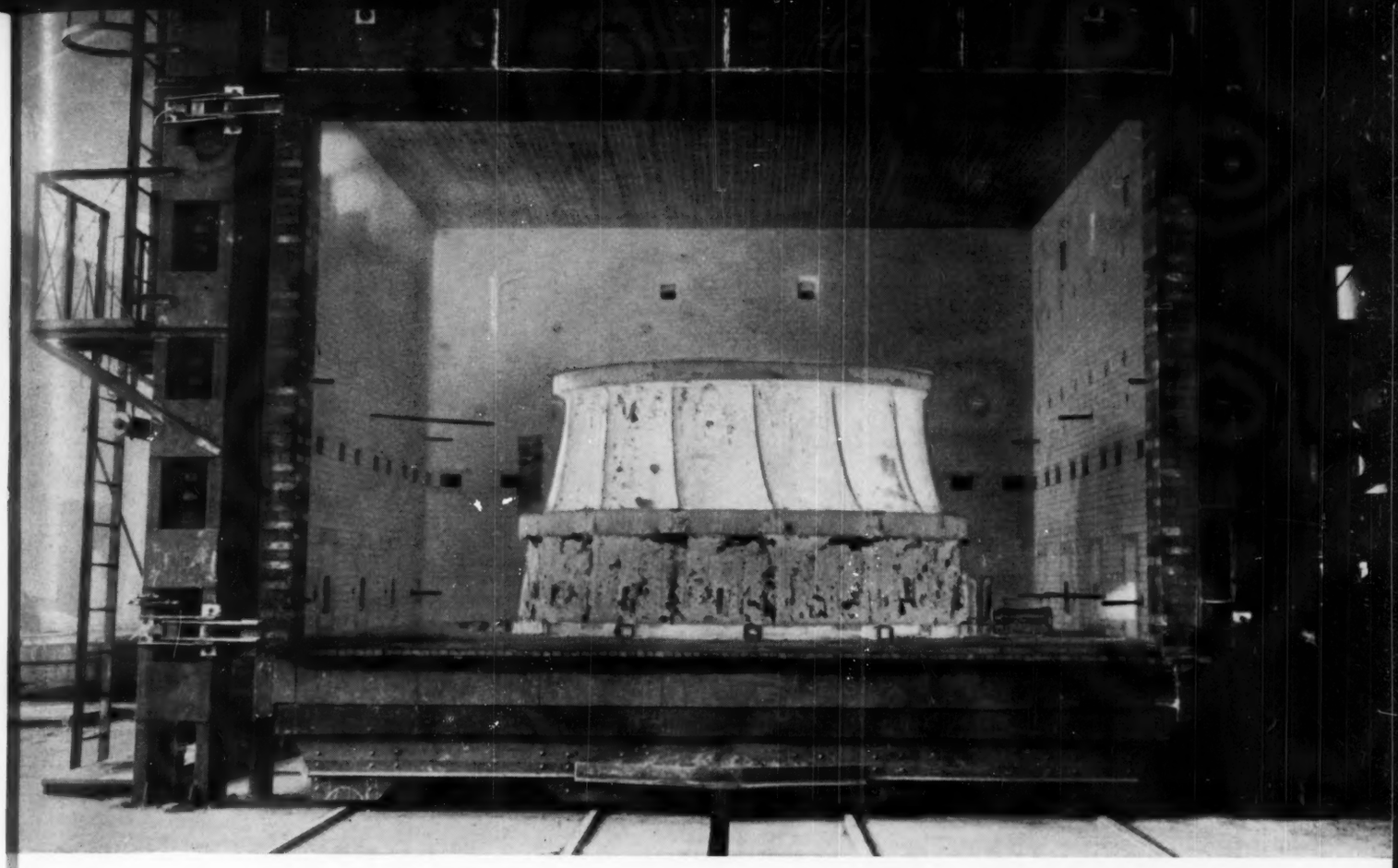
For More Complete Information write for this helpful booklet—

ABRASIVE CUTTING by ALLISON

ACCO

Allison Division • AMERICAN CHAIN & CABLE

254-G Island Brook Avenue, Bridgeport 8, Conn.



Annealing furnace in operation at Canadian Steel Foundries 1956 Ltd.

For best performance and maximum economy

7 different specialized refractories used in annealing furnace lining

Engineering a furnace lining with *specialized* refractories can save dollars on construction, fuel and maintenance as well as extend productive working time. To achieve these results, seven different B&W refractories were used in the lining of this 25′ x 23′ x 14′ annealing furnace.

Fuel savings and close temperature control were made possible by using three types of *lightweight* B&W Insulating Firebrick. Walls are composed of *B&W K-23 IFB* backed up with *B&W K-16*. Because of the proximity of the burners, the roof was constructed of *B&W K-26 IFB*, a higher temperature brick to guard against the effect of possible localized overheating.

The weight saving construction means about 100 lb less refractory material to heat up per sq ft than with ordinary firebrick, or about 28 tons less in the roof of the furnace. Furthermore, supporting steel is less massive, far less costly. Commercial size steel can be used for roof suspension instead of special steels.

To eliminate the need for expensive special shapes, the burner tunnels are formed of *B&W's 3000 F refractory castable, Kaocast*. Lintels over the burners and jambs are constructed of rugged *B&W Junior Firebrick*.

To take advantage of fast, easily installed castable construction, *B&W Kaocrete-D* was used in the nose arch (separately pictured). This sturdy castable with a 2500 F use limit was selected to provide strong resistance to abrasion caused by door operation. In addition, the need for costly fired shapes and their supporting castings was eliminated, as was a great deal of expensive engineering detailing.

Nose arch, cast of B&W Kaocrete D, immediately after removing forms.

The car top is insulated with *B&W Kaolite-20*, a 2000 F insulating refractory concrete.

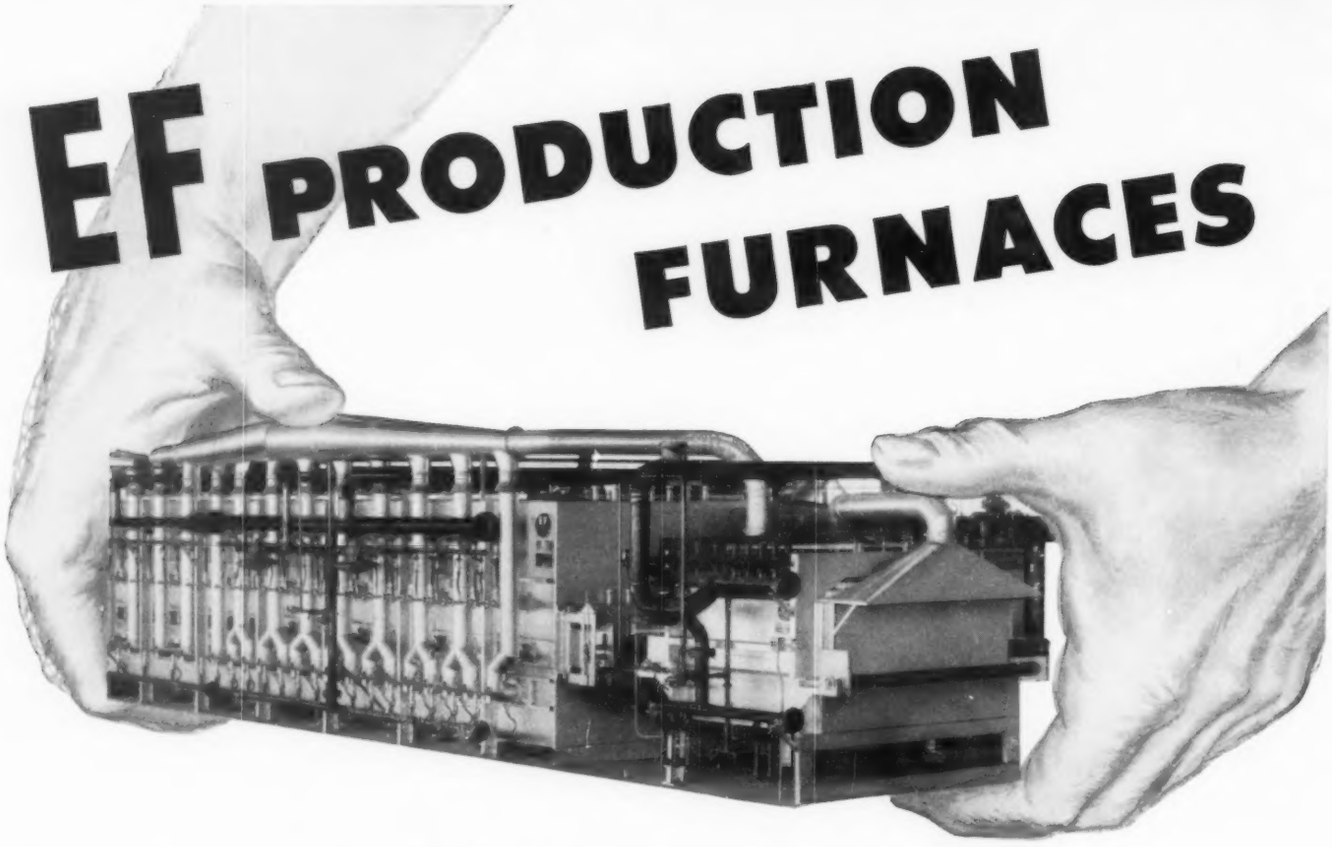
For further information, write for B&W bulletin R-2-H on insulating firebrick and B&W bulletin R-35 on castables.

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

R-574

EF PRODUCTION FURNACES

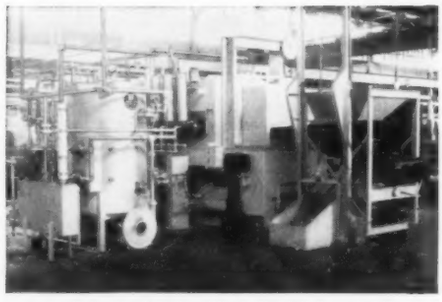


Designed, Built and Installed --- Ready to Produce

● It costs less to let experienced heat treating furnace engineers handle all phases of your heat processing furnace projects. Then you can be sure the design and type of furnace, the method of heating, the special atmosphere, the material handling and other equipment are all best suited for your particular product and process. All phases will be synchronized and coordinated to your production schedules, simplifying the entire operation and assuring profitable and trouble-free service.

EF engineers have served many of the country's most successful companies, and have handled many complete projects . . . some of extremely confidential nature.

On your next heat processing or furnace project, no matter how large or unusual, take advantage of the extensive experience and complete service offered by EF heat processing engineers — YOU'LL FIND IT PAYS.



A small, complete, compact installation consisting of an EF continuous scale-free hardening and gas carburizing furnace, a special combination endothermic and exothermic gas generator, automatic feeder, quench and discharge equipment.

A large combination gas fired and electrically heated continuous galvanizing furnace installation (over 300 feet long). As usual this equipment was completed and in production on schedule, and the first coil run thru was accepted as first class salable material.

THE ELECTRIC FURNACE CO.
GAS FIRED, OIL FIRED AND ELECTRIC FURNACES FOR ANY PROCESS, PRODUCT OR PRODUCTION
Salem - Ohio
Canadian Associates • Canefco Limited • Toronto 1, Canada

The subjects covered are measurement standards, primary elements, measurement systems, indicators and recorders, automatic controllers, electrical and pneumatic telemetering, final control elements, fundamental principles of process control and mathematical techniques for solving automatic control problems. Generally, the book gives a comprehensive and detailed compilation of descriptions and data relating to instrumentation and control, and though not covering any specific industrial use in detail, gives numerous examples of applications to show how the devices and principles described can be used in a variety of industries. Included in the book are a number of "firsts," including: a comprehensive survey of strain gages and other electrical pressure transducers; a thorough coverage of industrial weighing equipment; an adequate coverage of moisture-measuring systems; an extensive digest of photometric instrumentation and many others. Also covered are the fundamentals of automatic control; a condensed summary of the mathematical techniques used for solving automatic-control problems; and a glossary of over 1000 measurement and control terms, representing the present interpretations and practices of several professional engineering and scientific organizations. Throughout the handbook, adherence to the ASME standard automatic-control terms has been stressed. Ready-reference data are grouped in a classified reference section.

"Thermal Stresses," by B. E. Gatewood, has recently been published by the McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York 36, N. Y. The book contains 232 pages, 6 x 9 in., is cloth bound and sells for $7.50. The data given in this book are well organized and presented with emphasis on fundamental theory, and are applicable to many types of machines other than aircraft, including nuclear reactors, rocket motors, steam and gas turbines and their design and guided missile air frames. Covered herein are all phases of the analysis and design of structures at elevated temperatures, including temperature distribution, elastic and inelastic thermal stresses, combined applied and thermal stresses, allowable stresses of various materials

DURASPUN

20-FOOT FURNACE ROLLS
Centrifugally Cast

. . . of Duraloy HH Alloy, one of the most widely used high chrome, medium nickel alloys.

Two items concerning these furnace rolls may be of particular interest:

a—the size: 20 feet long—14" OD, ¾" wall thickness

b—welding operations by which reducing cones and shafts (both statically cast of the same alloy) were welded to the centrifugally cast rolls

These two items will serve to emphasize two phases of our service: (1) the large size centrifugally cast tubes we are able to produce and (2) our machining and finishing facilities, including welding.

Our new 16-page general Bulletin — 3354-G — gives complete details. Would you like a copy? When writing or calling would you mind telling us the general nature of your high alloy casting requirements? Better yet, if you have specific requirements on which we could help, let us have the details.

The DURALOY Company
OFFICE AND PLANT: Scottdale, Pa.
EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
ATLANTA OFFICE: 74—4th Street, N.W.
CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.

at elevated temperatures, and buckling, deflection, stiffness, fatigue, shock and flutter effects of elevated temperatures.

"Engineering Metallurgy," by Committee on Metallurgy (a collaborative writing group of 40 metallurgy professors), has recently been published by the Pitman Publishing Corp., 2 West 45th Street, New York 36, N. Y. The book contains 516 pages, 6 x 9 in., is cloth bound and sells for $7.50. The book presents in a concise and understandable manner the principles of ferrous and nonferrous metallurgy, with emphasis on metallurgical principles rather than on handbook information. However, specific data are given to provide a realistic structure to reinforce the theoretical presentations. The early chapters deal with the general principles of metallurgy as related to engineering, with one of these chapters devoted to basic problems of equilibrium and alloying; then nonferrous metals and alloys are discussed with complete coverage being given to these important materials; iron and steel are handled in succeeding chapters, with special attention given to the subject of heat treatment and ferrous alloys. The final chapters are devoted to machinability, corrosion and the effects of temperature. Principles, definitions and illustrative examples are presented. Drawings and photographs are used to amplify the discussion, with detailed tables included in certain chapters for reader convenience.

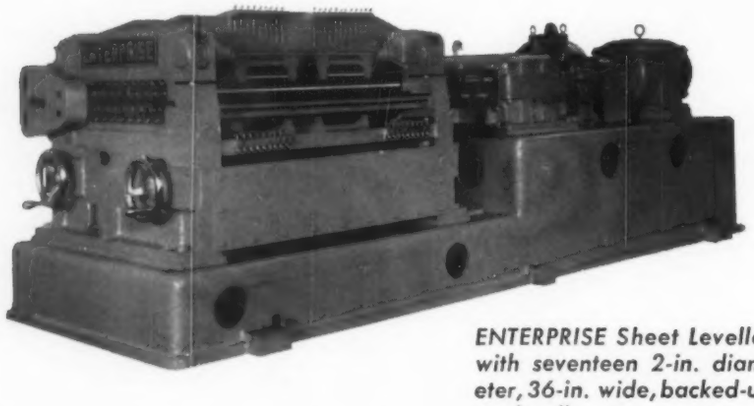
"Automation in Practice," by S. E. Rusinoff, has recently been published by the American Technical Society, 848 East 58th Street, Chicago 37, Ill. The book contains 261 pages, 5½ x 8 in., is cloth bound and sells for $6.50. The book begins with a discussion of basic principles and proceeds to the concrete application of these principles in the major types of control devices employed in today's automated and semiautomated plant. Chapters are devoted to the use of automatic equipment in virtually every area of metal production. The material presented is treated primarily in terms of particular processes rather than in terms of particular industries or particular products. Many line drawings and actual photographs of equipment are included.

"Work Sampling," by Ralph M. Barnes, has recently been published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. The book contains 283 pages, 6 x 9 in., is cloth bound and sells for $7.95. The book presents a thorough analysis of the technique of work sampling and provides an excellent reference and guide to such studies. The fundamentals essential to an understanding of the work sampling technique are explained clearly and lucidly, with specific directions supplied to show how to apply the techniques. Details of results of research done in this field and case histories are given to demonstrate the application of the technique in actual situations. Curves, charts, tables and scales are furnished, explaining and supporting the data.

"Design of Steel Structures," by Edwin H. Gaylord, Jr. and Charles M. Gaylord, has recently been published by the McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York 36, N. Y. The book contains 540 pages, 6 x 9 in., is cloth bound and sells for $8.00. The design of structural members and

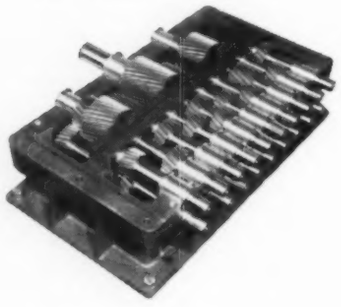
In SHEET LEVELING it's ENTERPRISE that counts

For the metal stamping industry, ENTERPRISE Roll-Type Sheet Levellers handle sheet and plate up to ¾"—level accurately, and also remove scale.



ENTERPRISE Sheet Leveller with seventeen 2-in. diameter, 36-in. wide, backed-up work rolls.

Bronze work roll bearings, antifriction back-up roll bearings, hardened alloy steel rolls and gears, powerful brushing rolls and automatic sheet spray, circulating lubricating system—plus 80 years of engineering design experience—guarantee the long life and dependable performance of these machines.



Helical Pinion Box for ENTERPRISE 17-roll Sheet Leveller.

WRITE FOR BULLETIN #402

ESTABLISHED 1878

THE ENTERPRISE COMPANY

Columbiana, Ohio • "Since 1878"

serves growing plant-air load at Rotary Electric Steel Co.

WHEN the Rotary Electric Steel Company of Detroit, Mich., increased plant capacity, the existing plant-air supply was also increased by adding the Ingersoll-Rand 100-hp PHE compressor shown above. The extreme simplicity of this installation is obvious at a glance.

The main air supply consists of two Ingersoll-Rand duplex, electric-driven compressors totaling 500 hp. After serving for 40 years they are still giving entirely satisfactory performance.

The new PHE unit is a compact, packaged-type, two-stage air compressor with built-in motor and efficient intercooler. It was shipped completely assembled, ready to run. Installation was simply a matter of mounting the unit on a small foundation and connecting the air, water and power lines. And like many other modern Ingersoll-Rand compressors the PHE has full-floating aluminum bearings that need no adjustments.

Ask your I-R representative for full details on the smooth-running PHE compressor. Its inherent longevity and low maintenance requirements mean big savings in air power costs.

Only I-R Compressors have CHANNEL VALVES

Known the world over for High Efficiency • Quiet Operation
Durability • Air-Cushioned Action • Corrosion-Resistance
Freedom from Warping • Long, Trouble-Free Service

Ingersoll-Rand

1-430

11 Broadway, New York 4, N. Y.

COMPRESSORS • ROCK DRILLS • AIR & ELECTRIC TOOLS
GAS & DIESEL ENGINES • TURBO-BLOWERS • PUMPS

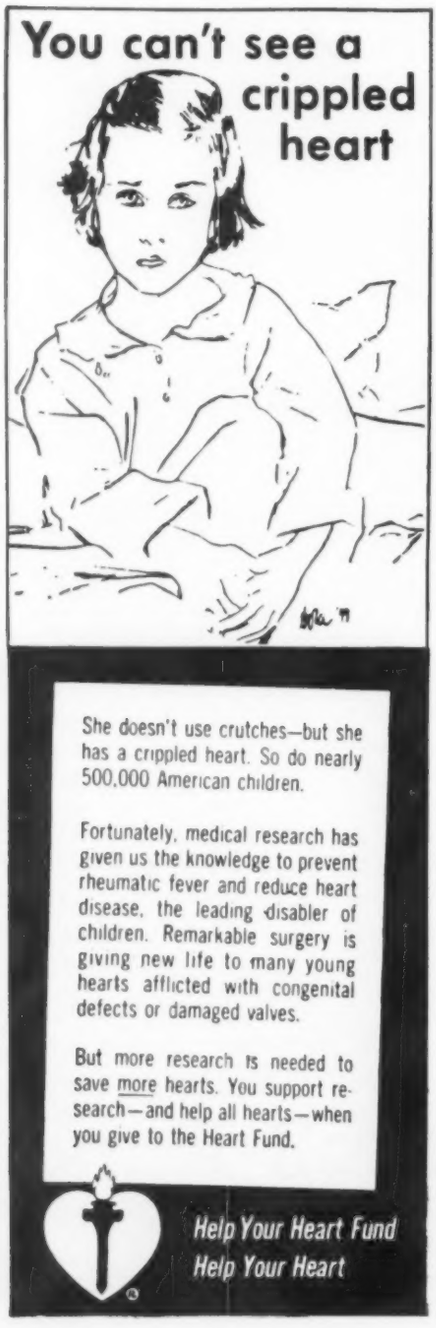
their connections, with applications to steel bridges and building frames is dealt with in this book, as well as some attention being given to aluminum because of its increasing importance as structural material. Ordinary loads, as well as earthquake loads and blast loads, for which bridges and buildings must be designed are discussed. Included are sections on the design of structural members in steel and aluminum; welded, riveted and bolted connections; plate-girder bridges; and industrial and multi-story buildings. There is a chapter on the application of theories of ultimate strength and plastic design, which gives an introduction to this development and an appraisal of the elastic theory as a basis for design. Each topic is introduced with a discussion of the relevant theory and with reference to experimental evidence, wherever feasible, emphasizing the relation of theory and tests to standard design specifications.

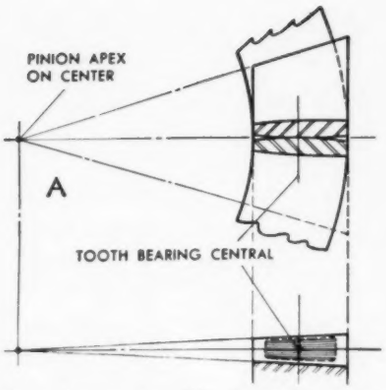
"NEMA Standards Publication for Transmission and Distribution Voltage Regulators, TR 6-1957" has recently been published by the National Electrical Manufacturers Assn., 155 East 44th Street, New York 17, N. Y. The book contains 32 pages, 8½ x 11 in., is heavy paper covered and sells for $2.00. Induction and step voltage regulators are covered in this revised book. Specific information is given concerning ratings, range of regulation, temperature rise, service conditions, tests, features and accessories, letter dimensions, terminal markings and cable connections.

"EEI-NEMA Standards for Secondary Network Transformers, NEMA Pub. No. TR 4-1957" has recently been published by the National Electrical Manufacturers Assn., 155 East 44th Street, New York 17, N. Y. The book contains 49 pages, 8½ x 11 in., with heavy paper cover and sells for 80¢. This joint publication contains design standards for certain mechanical and electrical features of three-phase, liquid-immersed, subway- and vault-type secondary network transformers rated 1000 kva and smaller, high-voltage 27,060 volts and below, low-voltage 216Y/125 volts.

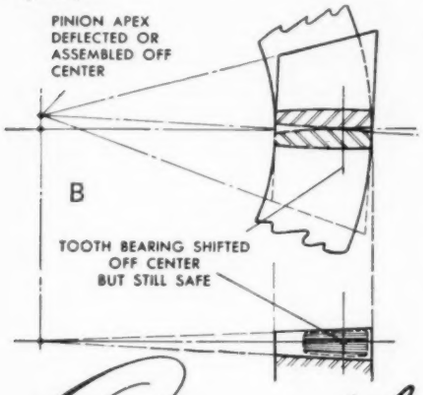
"Gray Iron Castings Handbook" was recently published by The Gray Iron Founders' Society, Inc., Cleveland, Ohio. The book edited by Charles F. Walton, technical director of the society, is the concentrated effort of several men. It contains 607 pages, 6 x 9 in., is cloth bound and sells for $10.00. This handbook presents in one volume technical data to serve the designer, purchaser or applicator of gray iron castings, and although presented in a practical vein, the contents are of assistance and value to the engineering student. Extensive data are

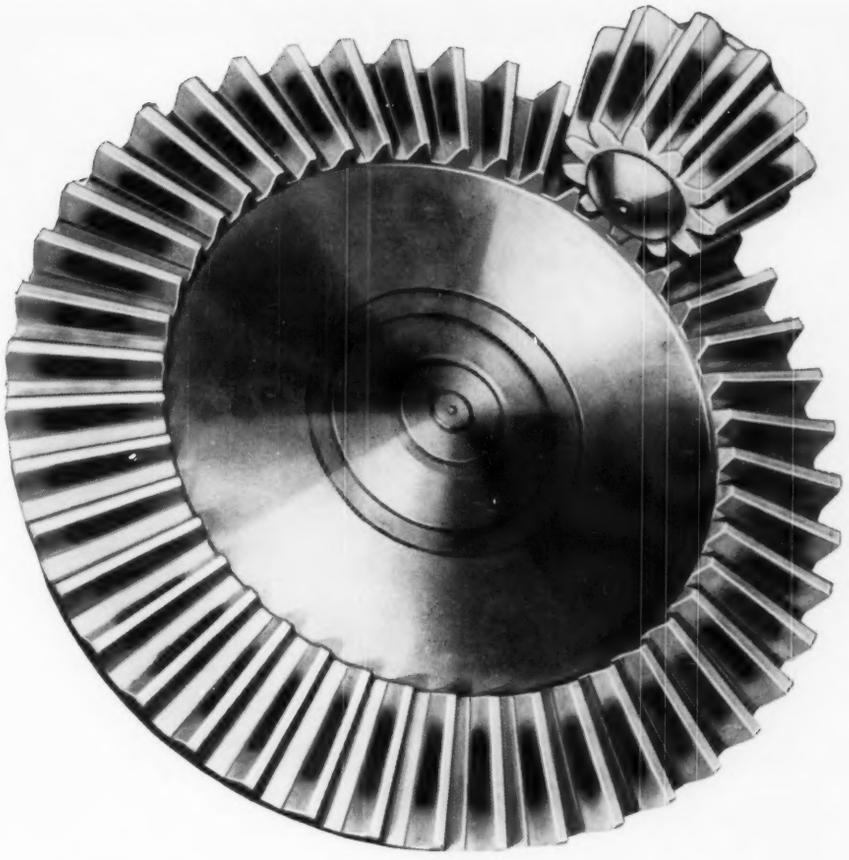
(*Please turn to page 254*)


You can't see a crippled heart
She doesn't use crutches—but she has a crippled heart. So do nearly 500,000 American children.
Fortunately, medical research has given us the knowledge to prevent rheumatic fever and reduce heart disease, the leading disabler of children. Remarkable surgery is giving new life to many young hearts afflicted with congenital defects or damaged valves.
But more research is needed to save more hearts. You support research—and help all hearts—when you give to the Heart Fund.
Help Your Heart Fund
Help Your Heart



Normal operation (a) displaced position (b). In the displaced position the load still is not concentrated on the ends of the teeth nor is length of contact materially shortened. Gears will continue to operate smoothly and quietly





what every gear user should know about

Coniflex® BEVEL GEARS

Coniflex Bevel Gears are gears that "ride with the punch". Inherent in the design of the gears is the ability to compensate for minor variations in mounting and assembly, and for the small gear displacement developed under operating loads. They are straight bevel gears with slightly rounded tooth flanks that maintain contact at the center of the teeth instead of the tips to produce a lengthwise localized tooth bearing. This localized tooth bearing produces a more durable gear that offers many advantages and economies to gear users. Available in sizes from 1" to 35½" in diameter, these gears are ideal for applications where speeds up to 1000 fpm pitchline velocity is adequate, and where transmission is at approximately right angles.

Industrial Gear makes all types of Industrial Cut Gears — a combination of precision and quality, reasonable cost, and superb service are as close as the phone on your desk.

Coniflex Generated Bevel Gears give you:

Economy — Many Coniflex gears can be generated from the rough blank in one operation.

Economy — Mounting tolerances permitted by the Coniflex tooth shape permit faster assembly.

Economy — Generating method inherently produces the correct tooth shape for any ratio and any number of teeth reducing design time and speeding production.

Economy — Longer gear life because the gears automatically compensate for mounting variations and displacement under operating loads.

Call your local Industrial Gear representative or write for full details about using Coniflex Bevel Gears in your product.

©REGISTERED TRADE MARK

INDUSTRIAL GEAR MFG. CO.

4529 W. Van Buren St., Chicago 24, Ill.

IT'S THE *Built-in Quality* THAT COUNTS!

Designed to fit your present resistor space

STEEL GRID RESISTORS
consistently prove their value in
STEEL MILL SERVICE

P-G has BOTH!

STANDARD Resistors

WELDED Resistors

Write for Bulletins

By use of those durable raw materials . . . steel and mica, and the P-G exclusive features of design, these Steel Grid Resistors have the "built-in quality" to overcome factors which often cause resistor failures. Vibration, moisture laden or corrosive atmospheres have little effect on continuity of service. Try Post-Glover Resistors for heavy duty applications where resistors are subject to severe service . . . continuous "Trouble-Free" performance is assured.

The Nonbreakable Steel Grid Resistor

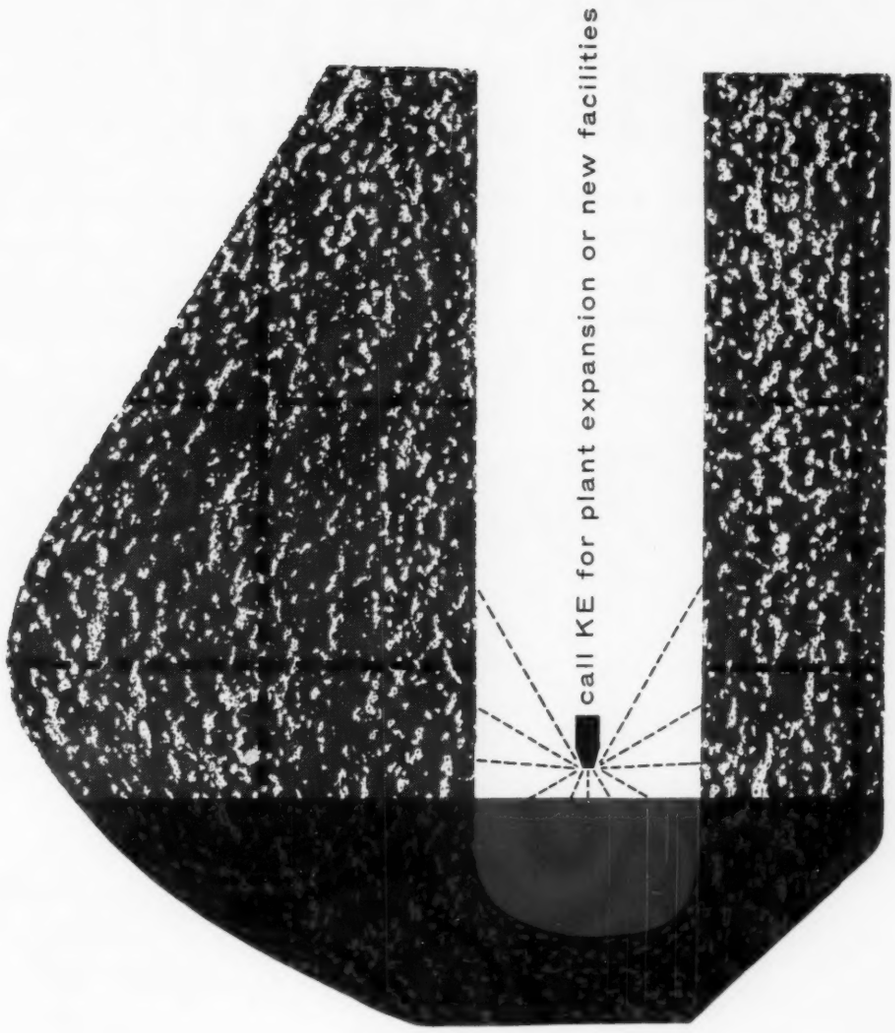
P-G

ESTABLISHED 1892

THE **POST-GLOVER** ELECTRIC COMPANY

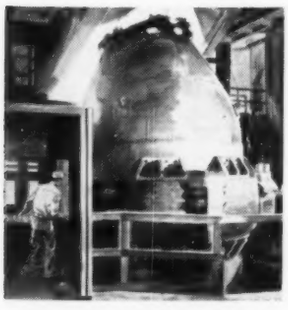
OFFICE and FACTORY—Kenton Lands Road, Erlanger, Kentucky

MAILING ADDRESS—Box 709, Covington, Kentucky



INGENUITY

has made KE the experienced leader in L-D Process Steel



L-D process plant similar to that now being installed by KE at a major eastern steel plant.

Design and construction of over 2,000,000 tons of oxygen steel making capacity. Intimate familiarity with oxygen steel technology in all parts of the world. A pioneer's experience in applying tested techniques of steel making. U.S. licensor for the proven L-D process—also P.T. Oxygen Guns for present and planned open hearths.

These are reasons why Kaiser Engineers is uniquely qualified to develop your oxygen steel program. Another reason is traditional KE ingenuity—engineering and construction ingenuity which means your steel facilities will be completed more quickly, at lower cost, and operate more efficiently.

Economic analysis, plant location, engineering, design, procurement, expediting, construction—KE does one or all. With your first thought of new steel producing facilities—call KE.

KAISER ENGINEERS engineers—contractors
Contracting since 1914

Division of Henry J. Kaiser Company • Oakland 12, California • New York, Pittsburgh, Washington, D.C., Buenos Aires, Calcutta, Dusseldorf, Montreal, Rio de Janeiro, Sydney, Tokyo

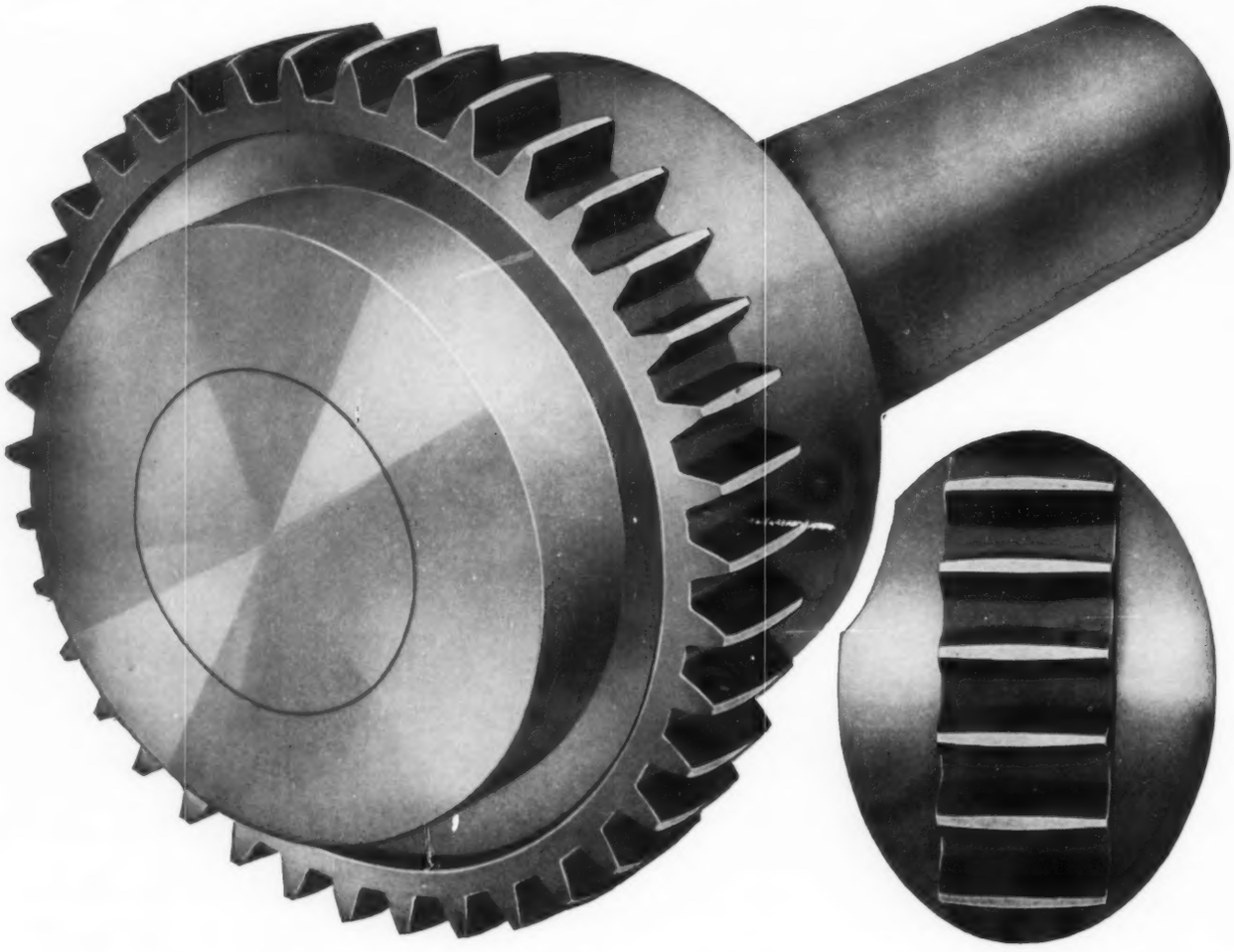
4381

POOLE

CURVED TOOTH COUPLINGS FOR GREATER MISALIGNMENT

We are now equipped to furnish on special order, couplings up to and including size No. 12 with curve-sided hub teeth, permitting misalignment up to plus or minus 5°.

This feature solves many problems where excessive misalignment becomes unavoidable, such as coupling arrangements which necessitate changing centers of rolls etc., or any sort of drive requiring more than the standard plus or minus 1°.



The method by which this is done represents the very latest gear cutting process. Gear teeth cut by this amazing and ultra modern method are not only to a precise and absolutely true shape, but are also generated to tolerances of astounding accuracy.

Engineers and draftsmen, when confronted with coupling problems involving more than the usual amount of misalignment, are invited to submit such problems to us for recommendation to suit their exact requirements.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY **1700 UNION AVE.** **BALTIMORE 11, MD.**

THE ENGINEERING MART

WHERE TO BUY
EQUIPMENT FOR SAL
POSITIONS VACANT
POSITIONS WANTED

AN *IRON and STEEL ENGINEER* SERVICE TO THE STEEL MILL OPERATORS

WHERE TO BUY

BIRMINGHAM DISTRICT

DIXIE ENGINEERING COMPANY
"Manufacturer's Agents"
812-813 Protective Life Building
BIRMINGHAM 3, ALABAMA
Sabel E. Baum — Telephone 4-0417

CHICAGO DISTRICT

PAUL W. WENDT & SONS
Manhattan Building
CHICAGO 5, ILLINOIS
District Representatives for
A. W. CADMAN MFG. CO.
HUNTER SAW & MACHINE CO.
GRAFO COLLOIDS CORP.

EHRET AND KINSEY
Board of Trade Bldg., 141 West Jackson Blvd.
Chicago 4, Illinois — Wabash 2-0449
Representing
THE CLEVELAND WORM AND GEAR CO.
"Cleveland" Worm Gearing and Worm Gear Speed Reducers—30 Years
THE FARVAL CORPORATION
"Farval" Centralized Lube Systems—30 Years
LUBRICATION PRODUCTS COMPANY
"Strapax" Journal Box Lubricator—24 Years
AMERIGEAR-ZURN, INC.
"Amerigear" Flexible Couplings—9 Years
WALDES KOHINOOR, INCORPORATED
"Truarc" Retaining Rings—11 Years
AMERIGEAR-BLISS SPINDLE COUPLING DIVISION, E. W. BLISS CO.
Spindle Couplings
3904 West Vliet St. — Phone:
Milwaukee 8, Wisc. — Division 2-7844

The C. W. THOMSON COMPANY
"Wired Communication Specialists"
- Loudspeaking Communication & Paging
- Battery Operated Portable Equipment

1718 Tytus Avenue — Middletown, Ohio

PITTSBURGH DISTRICT

ROLLING MILLS and EQUIPMENT
FRANK B. FOSTER, INC.
2220 OLIVER BUILDING PITTSBURGH 22, PA
Cable Address "FOSTER" Pittsburgh

PITTSBURGH (Continued)

ELECTRICAL INSTALLATIONS
PATTERSON EMERSON COMSTOCK, INC.
PITTSBURGH, PA.

STEEL MILLS—INDUSTRIALS UTILITIES
313 EAST CARSON ST. — ZONE 19

W. G. KERR CO., INC.
1005 Liberty Ave. — PITTSBURGH, PA.
Phone: ATlantic 1-4254
Representing:
FOOTE BROS.—Gears and Speed Reducers
REEVES—Variable Speed Drives
THOMAS—Flexible Couplings
WICHITA—Air Tube Disc Clutches & Brakes
TELSMITH—Telsmith Crushers
CULLEN-FRIESTEDT—Sheet Lifters—Welding Positioners—Track Cranes

The* CALVERT *Co.
***Producers of* Calvert Bus**
- BARE BUS FABRICATION
- CABLE LEADS, Air and liquid cooled
- JUNCTION BOXES, 600 to 23,000 volts
- HIGH AMPERE TERMINALS

ED. 3-0353
19851 Ingersoll Dr., Rocky River 16, O.

AUBURN AND ASSOCIATES, INC. ENGINEERS
COMPLETE
ENGINEERING . DESIGN . LAYOUT
FOR
STEEL MILLS AND HEAVY INDUSTRY
923 Penn Ave., Pgh. 22, Pa.
Telephone COurt 1-5014

PITTSBURGH (Continued)

RITTER ENGINEERING CO.
Engineers • Distributors • Contractors
1409 SEDGWICK ST. — Phone:
PITTSBURGH 33, PA. — FAIRFAX 1-8538
TRABON—Centralized Lubricating Systems
METERFLO—Circulating Oil Systems
PARKER—Hydraulic & Fluid System Components
"Specialists in Lubrication and Hydraulics"

METALLIC RECUPERATORS
(Air Preheaters)
For application to soaking pits, heating, and other types of metallurgical furnaces.
HAZEN ENGINEERING CO.
184 Sandy Creek Road — (Penn Township)
P. O. Box 10597 — PITTSBURGH 35, Pa.
CHurchill 2-1750

CONSULTING ENGINEERS

W. VANCE MIDDOUGH & ASSOCIATES
Consulting Electric Engineers
Engineering • Design • Layout
Heavy Industrial Power & Light
Frederick Building — Cleveland 15, Ohio
Prospect 1-2060

MARTIN J. CONWAY
Consulting Fuel Engineer
111 South Duke Street — Millersville, Pa.
Tel. 6153
Steel Industry Representative for
CHEMICAL CONSTRUCTION CORPORATION
P-A- VENTURI SCRUBBER
Cleaning Blast Furnace, Converter, Open Hearth and Scarfing Gases. Bulletins Available.

ROSS E. BEYNON
Consultant
ROLLING LAYOUT AND ROLL DESIGN
7658 Coles Avenue — Chicago 49, Illinois
Telephone SAginaw 1-3466

ENGINEERING SERVICE BUREAU
Consultants & Design Engineers For The Steel Industry
BEN MACCABEE — 173 W. Madison St.
S. L. JAMESON — CHICAGO 2, ILLINOIS

USE THE ENGINEERING MART

THE ENGINEERING MART

Consulting Engineers (Continued)

HOUSER AND CARAFAS ENGINEERING CO.

Engineering for Industry

4 Smithfield Street Pittsburgh 22, Pa.

Phone: GRant 1-9929

PRODUCTS

STANAT

Precision 2-High 4-High combination rolling mills, slitters and roller levelers

Henry S. Rondeau
2865 Coventry Rd.
Cleveland 20, Ohio

LOngacre 1-7168

FOR SALE

NINE (9) SERARATE OXYGEN PRODUCING PLANTS

Varying in size from 40 meters to 200 meters.

All being operated at the present time, and in good working condition.

Some available at once, balance in 60–90 days.

Offered complete, f.o.b. operating point.

For complete details, send inquiry to

BURDETT OXYGEN CO.

3300 Lakeside Ave. Cleveland 14, Ohio

POSITIONS VACANT

WANTED

CHIEF METALLURGIST

Excellent opening for experienced metallurgical engineer in a fully integrated steel mill. Must have ability to head large department handling such diverse responsibilities as physical and chemical testing, customer service, inspection, and quality control.

Top salary for right man.

Contact Chas. D. Dorworth, Director of Personnel, Alan Wood Steel Co., Conshohocken, Pa.

Book Reviews

(Continued from page 248)

compiled on significant engineering properties of gray, ductile, white and high-alloy irons. The contents also include information on how to use heat treatment to make castings possess commercially valuable properties superior to the "as cast" condition. The heat-treating procedures are described in detail with specific information on types, mechanisms, temperatures, times and rates of cooling. The chapter on welding, joining and cutting of gray iron in fabricated assemblies explains in detail the new methods of performance to make it possible to satisfactorily weld gray iron to itself and to join it to other metals and castings. Information on machining and grinding is also presented. There are many photographs, charts, tables, etc., to illustrate and explain the text.

"Creep and Fracture of Metals at High Temperatures" has recently been published by the Philosophical Library, Inc., 15 East 40th Street, New York, 16, N. Y. The book contains 419 pages, 8 x 10¼ in., is cloth bound and sells for $12.00. This volume contains the proceedings of an international conference held in 1954 at National Physical Laboratory, Teddington, Middlesex, England. The knowledge of the processes taking place during the creep of metals is reviewed, and methods of controlling the phenomena that determine the strength of metals at high temperature are discussed. Twenty-two papers, which have been revised and added to by the authors, and the discussions which followed these presentations, are contained in the book.

"ASTM Standards on Electrical Insulating Materials," issued September, 1957, has been published by the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa. The book contains 692 pages, 6 x 9 in., is bound in heavy paper and sells for $6.00. These data, prepared by ASTM Committee D-9 on Electrical Insulating Materials, are an up-to-date and handy compilation of ASTM test procedures and specifications for electrical insulation for use of manufacturers of equipment and those associated with the use and distribution of electrical power.

VIGILANCE

The final victory over cancer will come from the research laboratory.

But there is a more immediate victory at hand today. Many cancers can be cured when detected early and treated promptly. *Vigilance* is the key to this victory.

There are certain signs which might mean cancer. Vigilance in heeding these danger signals could mean victory over cancer for you:

1. **Unusual bleeding or discharge.**
2. **A lump or thickening in the breast or elsewhere.**
3. **A sore that does not heal.**
4. **Change in bowel or bladder habits.**
5. **Hoarseness or cough.**
6. **Indigestion or difficulty in swallowing.**
7. **Change in a wart or mole.**

If your signal lasts longer than two weeks, go to your doctor to learn if it means cancer.

AMERICAN CANCER SOCIETY®

INDEX TO ADVERTISERS

FEBRUARY, 1958

A

Adalet Mfg. Co., The ... 232
Aetna-Standard Engineering Co. ... 1
Air Products, Inc. ... 171
Allen-Bradley Co. ... 38
Alliance Machine Co. ... 60, 61
Allis-Chalmers Manufacturing Co. ... 2
Allison Div.,
American Chain & Cable Co., Inc. ... 242
American Air Filter Co. ... 13
American Chain & Cable Co., Inc.,
Allison Div. ... 242
American Shear Knife Co. ... 248
Askania Regulator Co. ... 54
Atlas Car and Mfg. Co. ... 240
Automatic Transportation Co. ... 59

B

Babcock & Wilcox Co., The ... 243
Bailey Meter Co. ... 199
Bearings, Inc. ... 216
Bendix Aviation Corp.,
Cincinnati Div. ... 205
Berry Bearing Co. ... 39
Birdsboro Steel Foundry & Machine Co. ... 7
Blaw-Knox Co.,
Foundry and Mill Machinery Div. ... 55
Bliss Co., E. W. ... 26
Bloom Engineering Co., Inc. ... 18
Borg-Warner Corp.,
Industrial Crane & Hoist Div. ... 66
Bristol Co., The ... 58
Browning and Co., Inc., Victor R. ... 188
Buffalo Forge Co. ... 50
Bussmann Manufacturing Co. ... 166, 167

C

Chemical Construction Corp. ... 189
Clark Controller Co. ... 5
Cleveland Crane and Engineering Co. ... 10
Cleveland Worm and Gear Co., The ... Cover 3
Cone-Drive Gears Div.,
Michigan Tool Co. ... 48, 49
Crouse-Hinds Co. ... 186
Cunningham Co., M. E. ... 206
Cutler-Hammer, Inc. ... Cover 2, 182

D

De Laval Steam Turbine Co. ... 241
DeZurik Corp. ... 225
Diamond Power Specialty Corp. ... 195
Documentation and Licenses, Paris, France ... 37
Dodge Manufacturing Corp. ... 176
Dowell, Inc. ... 233
Dravo Corp. ... 40
Drever Co. ... 69
Duraloy Co., The ... 245

E

Electric Controller & Mfg. Co.,
Square D Co. ... 32, 33, 63
Electric Furnace Co., The ... 244
Electric Machinery Mfg. Co. ... 231
Electric Service Works, Delta-Star Electric Div.,
H. K. Porter Co., Inc. ... 228
Electro-Alloys Div.,
American Brake Shoe Co. ... 22
Elliott Co. ... 215
English Electric Co. of Canada, Ltd. ... 235
Enterprise Co., The ... 246
Euclid Electric & Mfg. Co., The ... 189
Exide Industrial Div.,
Electric Storage Battery Co. ... 236

F

Feller Engineering Co. ... 175
Femco, Inc. ... 230
Flinn and Dreffein Engineering Co. ... 37

G

General Electric Co. ... 14, 15, 42, 43, 44, 45, 196, 197
Great Lakes Carbon Corp. ... 67, 237
Guyan Machinery Co. ... 177

H

Hallden Machine Co., The ... 37
Harbison-Walker Refractories Co. ... 21
Hauck Manufacturing Co. ... 206
Heyl and Patterson, Inc. ... 25
Hill Acme Co.,
Cleveland Knife Div. ... 217
Hyde Park Foundry and Machine Co. ... 198

I

Industrial Gear Mfg. Co. ... 249
Ingersoll-Rand Co. ... 247
I-T-E Circuit Breaker Co. ... 8, 9

K

Kaiser Aluminum and Chemical Corp., Inc. ... 229
Kaiser Engineers ... 251
Koppers Co., Inc. ... 179, 207

L

Larco, Inc. ... 238
Lectromelt Furance Div.,
McGraw-Edison Co. ... 72
Link-Belt Co. ... 12, 56, 239
Loewy-Hydropress Div.,
Baldwin-Lima-Hamilton Corp. ... 220
Loftus Engineering Corp. ... 234

M

Mackintosh-Hemphill Div.,
E. W. Bliss Co. ... 190
Manning, Maxwell and Moore, Inc. ... 168
Mansaver Industries, Inc. ... 205
Master Builders Co. ... 206
Mesta Machine Co. ... 208
Miles and Partner, John, London, Ltd. ... 37
Minneapolis-Honeywell Regulator Co. ... 218, 219
Morgan Construction Co. ... 35
Morgan Engineering Co., The ... 178
Morgardshammars ... 212

N

National Bearing Div.,
American Brake Shoe Co. ... 222, 223
National Carbon Co.,
Union Carbide Corp. ... 71
National Electric Coil Co. ... 256
North American Manufacturing Co. ... 187

O

Ohio Electric Mfg. Co., The ... 68
Ohio Steel Foundry Co., The ... Cover 1

P

Pangborn Corp. ... 41
Pannier Corp., The ... 225
Pennsylvania Transformer Div.,
McGraw-Edison Co. ... 172
Pittsburgh Engineering & Machine Co. ... 62
Poole Foundry and Machine Co. ... 252
Post-Glover Electric Co. ... 250

R

Radio Corp. of America ... 185
Ramtite Co., The ... 221
Reliance Electric and Engineering Co. ... 51
Republic Flow Meters Co. ... 30
Rockbestos Products Corp. ... 224
Rockwell Co., W. S. ... 232
Rust Furnace Co. ... 163
Rust-Oleum Corp. ... 64, 65

S

Salem-Brosius, Inc. ... 52
Selas Corp. of America ... 180, 181
Sheffield Corp. ... 225
Spraying Systems Co. ... 4
Stamco, Inc. ... 170
Surface Combustion Corp. ... 46, 47
Sutton Engineering Co. ... 194
Syntron Co. ... 211

T

Taylor Chain Co., Inc., S. G. ... 170
Taylor Sons Co., Chas., The ... 34
Texas Co., The ... Cover 4
Timken Roller Bearing Co., The ... 29
Tool Steel Gear & Pinion Co. ... 19
Torrington Co., The ... 16
Trabon Engineering Corp. ... 226

U

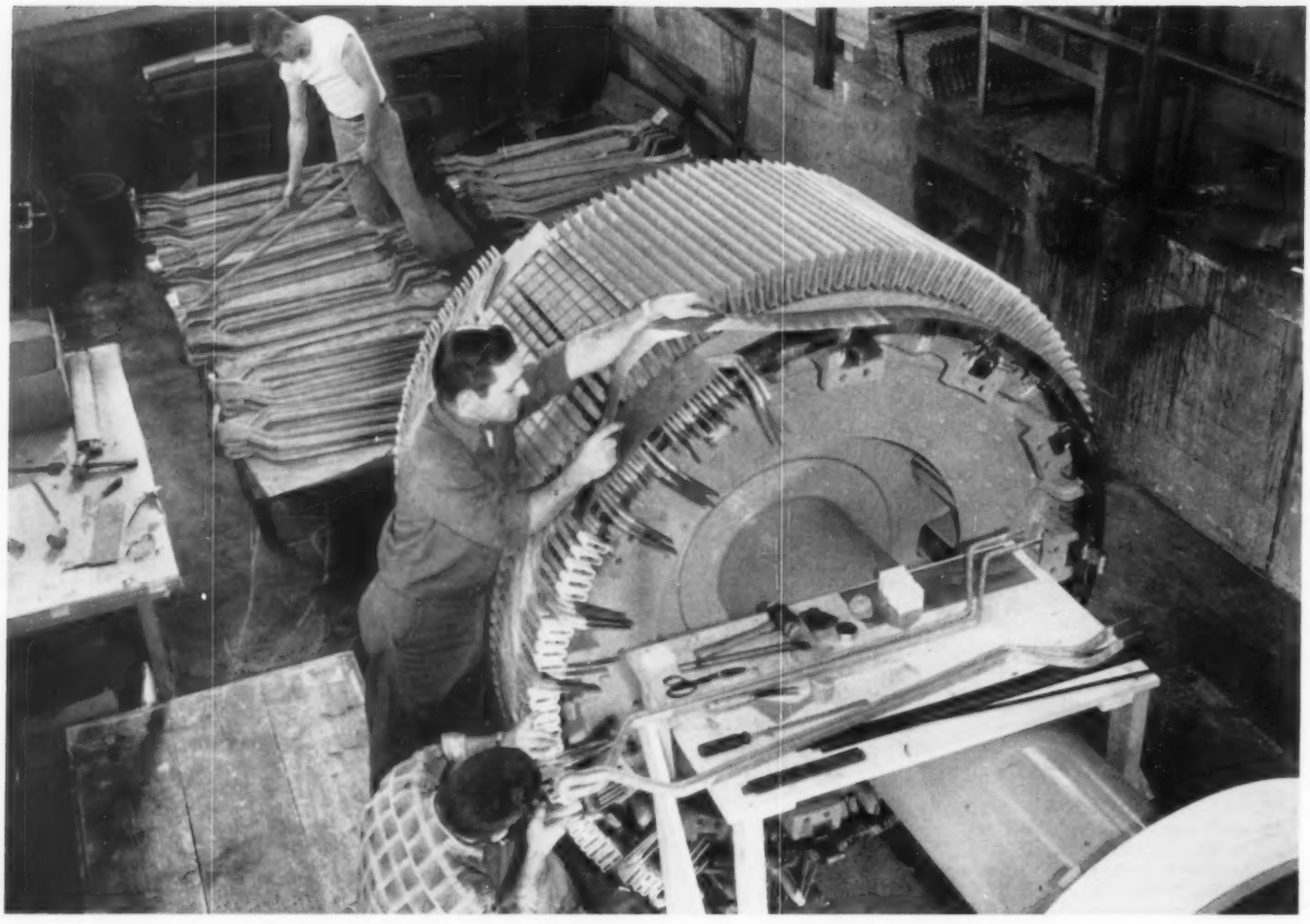
Union Carbide Corp.,
National Carbon Co. ... 71
United Engineering and Foundry Co. ... 17
United States Graphite Co. ... 36

W

Wagner Electric Corp. ... 200
Wean Engineering Co., Inc., The ... 37
Wean Engineering Co. of Canada, Ltd., The ... 37
Wean Equipment Corp. ... 37
Western Gear Corp. ... 53
Western Precipitation Corp. ... 20
Wheelabrator Corp. ... 31, 192
Wilson Engineering Co., Inc., Lee ... 6

Y

Yoder Co., The ... 70
Youngstown Alloy Casting Corp. ... 57
Youngstown Welding and Engineering Co. ... 193



here's how NATIONAL saved a steel mill time and money by changing the operating characteristics of a motor

A midwestern steel mill needed a 60-cycle motor to drive two generators which furnished D.C. power for a rolling mill. They had available a 25 cycle, 2300 V. motor rated at 5,000 HP, 375 RPM. When asked to convert this to the mill frequency, National redesigned and rebuilt it to 60 cycle, 4,000 HP, 12,000 V., 360 RPM—adequate for all requirements. Winding of the rotor is shown in photo above.

Where redesign can produce the change you need, it offers substantial savings over the cost of new equipment—particularly when you can take advantage of idle equipment you already own.

When time is a factor, redesign and rewinding can be completed in a much shorter time than it normally takes to get delivery on a new machine.

For detailed information on similar problems of your own, give your nearby National field engineer a call or get in touch with us here in Columbus.

NATIONAL ELECTRIC COIL COMPANY

COLUMBUS 16, OHIO, U. S. A. TRADE MARK

ELECTRICAL ENGINEERS: MAKERS OF ELECTRICAL COILS AND INSULATION—REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

Clevelands drive cooling bed of highly automated Canadian tube mill

Here is the cooling bed—driven by 3 Cleveland speed reducers—of the world's first completely automated seamless tube mill. It was built by Mannesmann-Meer Engineering & Construction Co., Inc., Easton, Pa., and installed at the Sault Ste. Marie plant of Mannesmann Tube Company.

Practically everything in the entire plant is automatic—handling of materials from stage to stage, as well as individual operations.

You'll find Clevelands in nearly every steel plant in America—wherever dependable, heavy duty drives are demanded—many of them in continuous service upward of 35 years. Write for new Bulletin 145 which shows the many types available in the Cleveland line. The Cleveland Worm and Gear Company, 3278 East 80th Street, Cleveland 4, Ohio.

CLEVELAND
Worm Gear
Speed Reducers

Affiliate: The Farval Corporation, Centralized Systems of Lubrication.
In Canada: Peacock Brothers Limited.

PREVENT METAL-TO-METAL CONTACT EVEN UNDER EXTREME PRESSURES WITH MEROPA LUBRICANT

Because Texaco Meropa's protective film stays in place, reduction gears and bearings run smoother, last longer, cost less to maintain.

Texaco's special polar additives bond Meropa's protective film to gear surfaces. This, in conjunction with Meropa's extreme pressure properties, assures that neither shock nor heavy, steady gear loads can break the protective barrier between working metal surfaces—*the film remains*. It protects gear surfaces against galling, scoring, and other causes of failure.

Where Texaco Meropa is present, protection stays complete. Texaco Meropa Lubricant resists oxidation. It will not separate or foam. It is an ideal, long lasting, heavy-duty, gear lubricant . . . a constant combatant against the destroying effects of heat, pressures and other ever present causes of gear failure.

A Texaco representative can help you select the Texaco Meropa Gear Lubricant designed for your operation. Simply call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write: The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TUNE IN . . . Metropolitan Opera Radio Broadcasts Every Saturday Afternoon

LUBRICATION IS A MAJOR FACTOR IN COST CONTROL

(PARTS, INVENTORY, PRODUCTION, DOWNTIME, MAINTENANCE)